DISCOVERY

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Notes of the Month.

Not only scientists, but every member of the general public who takes an interest in the advance of knowledge, and in the very distinct effect that this advance is having on his everyday life, should find great interest in the recently published *Annual Report of the Department Scientific and Industrial Research* (H. M. Stationery Office. 3s.). The advisory council of the Department, of which Lord Rutherford is chairman, call attention first and foremost to a significant development in the attitude of industry towards research; scientific advance in industry is not now dependent on the flashes of genius of the brilliant individual, though this country has never been lacking in inventive capacity. "What is new," the report states, "in present times is the way in which industry has taken up new ideas and brought them to the stage of industrial application by team work in which the scientists, the technical men, and in fact all the departments into which a great business is organised have worked side by side in the practical attainment of an objective."

* * * *

From this it is easy to understand the importance attached to the development of co-operative research stations within the Department; and the erection of several groups of new laboratories—notably for Electrical Research and Cotton Research—is therefore a matter for congratulation. Industry, however, has not always responded to the offers of mutual assistance made by the Department, and more development might have been recorded in many cases, had contributions been forthcoming equivalent to those offered by the Department. One of the most interesting results of the year has been in connection with radio research. Three new electrified regions in the atmosphere have been discovered between four and forty miles above the earth. These regions are thus well below the well known Heaviside and Appleton layers which play such an important part in carrying broadcasting to long distances. The new layers are likely to be important in connection with the travel of very short waves which are able to pass without reflection through the upper layers. "Isolated trials on high frequencies including those in use for television have not yet indicated any frequency so high that its return from the middle atmosphere can be regarded as unusual." It is believed that local thunderstorms are a probable source for replenishing the electricity in the newly discovered layers.

* * * *

Interesting physical work has been carried out in connection with radium treatment of diseases. The strength of the radiations from a specially designed radium unit, with which various radium "skin distances" can be obtained, have been measured in a celluloid vessel containing water and giving the same scattering and absorption effects as a human body. Means have been developed for accurately measuring and controlling tissue-dosage. Another investigation is in progress in connection with the weak radiations which may reach distant parts of a patient's body during treatment. These radiations, it is believed, may be of importance in "constitutional effects" of radium treatment, *e.g.*, blood changes and general health. The method used is to measure the electricity produced (ionisation) in air gaps in a laminated celluloid model of the body. The improved apparatus for investigating artificial radioactivity is being used in a search for new radio elements of very short life whose existence is suspected. The impulses resulting from atomic disintegrations are recorded on a specially designed new

film camera, which permits high counting speeds up to 20,000 per minute. Particular attention is being given to the elements that occur in the human body.

* * * *

M. R. Vaufrey of the Institut de Paléontologie Humaine, Paris, who has made a special study of the Stone Age in North Africa, notably in Morocco and Tunis, has receuly made an important contribution to the investigation of the chronological problems of that area, and, inferentially, of the western Mediterranean. He demonstrates: (1) that the skeletal remains from the shell middens of Mechta el-Arbi in Tunis, which are the type series for the early form of " modern " man in this region, belong not, as thought, to the Capsian, which in the cultural succession of North Africa holds, so far as is at present known, a position corresponding to the Aurignacian in the European Old Stone Age succession, but to a later form, the Upper Capsian, and is, therefore, of Mesolithic age; (2) that the naturalistic rock sculptures of North Africa and the Sahara, over the dating of which there has been much controversy, belong, in fact, to this Upper Capsian, or the following period, a Neolithic with Capsian tradition; and (3) that the Neolithic element in this later culture was derived from the Nile Valley and was a composite product, showing features belonging to each of the successive predynastic cultures of Egypt, their synchronism in North Africa being due to the time lag of a provincial culture. Consequently by correlation with the Egyptian dating it is shown that the florescence of this Neolithic-Capsian culture may be dated between 4,000 B.C. and 1500-1000 B.C.

* * * *

A total attendance of 293,000 in the year 1935-36 has been recorded at the Museum of Practical Geology, South Kensington. This compares favourably with an annual attendance of something like 20,000 at the old Jermyn Street Museum and is gratifying evidence of the success of the efforts made in the new building to present the results of geological research in an attractive and understandable form. Demonstrations and guide-lectures have also proved remarkably popular. Upwards of 80 demonstrations to parties of visitors and students have been given by members of the staff and a whole-time officer has been appointed to the post of Guide-Lecturer.

* * * *

The citizens of Wellington and the people of the Dominion of New Zealand are to be congratulated on the new National Art Gallery and Dominion Museum, the first and larger portion of which was opened to the public towards the close of 1936. The new buildings, occupying a commanding site on Mount Cook, above the city, contain also the headquarters of various scientific services and the libraries of the N.Z. Institute and the Wellington Philosophical Society. In the illustration herewith the building (by Messrs. Gummer & Ford, of Auckland) is shown with the campanile which precedes it and which combines with the museum to serve as a National War Memorial. The importance of the adequate housing of National collections of art and science is nowhere of greater urgency than in New Zealand, a country which occupies a position that is unique in the realms of both natural history and ethnology; and the museum provides an ideal setting for the magnificent collection of Maori art and workmanship, and for the remarkable birds, reptiles, and insects that are peculiar to this Dominion. Generous bequests have supplemented the exhibits of local interest with valuable art collections of European provenance.

[*By courtesy of the Editor of the Museums Journal.*

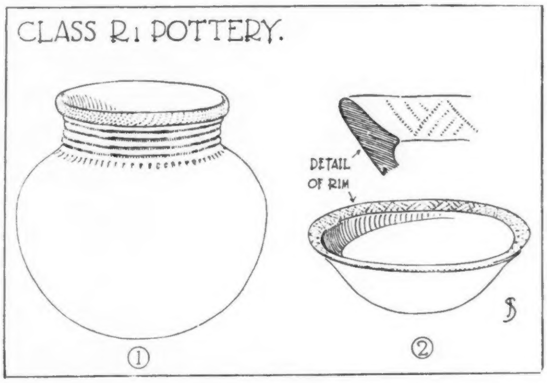
National Museum and Art Gallery, Wellington, N.Z.

The Builders of Zimbabwe

By J. F. Schofield.

In our issue for June 1936 we asked a series of questions regarding the puzzling African ruins of Zimbabwe. To all of these questions simple and adequate answers exist, and Mr. Schofield, from a long study of the subject, claims to supply them in the article which follows.

WHO, it is asked, were the builders of Zimbabwe? We know from the occurrence of three characteristic classes of pottery that its builders belonged mainly to three branches of the south-eastern Bantu, viz. :—the Sutho, the Shona and the Roswi-Venda peoples. The first class of pottery, which I have called Class R1, has been identified on such widely distributed sites as Madiliyangwa near Bulawayo, Salisbury Commonage, Umtali, and Gokomere, and cognate, but not identical pottery has been discovered in the Limpopo Valley sites at Parma and Mapungubwe. The first four of these sites are in caves, and in at least one of them, that at Salisbury, the pottery sherds were found in the same stratum as Wilton material; at the other sites they were found directly overlying Middle and Late Stone Age cultures. At Dhlo-Dhlo and Zimbabwe this pottery was found beneath the sealed floors of the later occupants; therefore there can be little doubt that we have in this ware the handiwork of the earliest Bantu inhabitants of the country.



This pottery has been found directly overlying Middle and Late Stone Age culture material.

Unfortunately, all the examples which have been described are so small that it is difficult to form an idea of the appearance of the original pots, and this deficiency will not be made good until the report on the exceedingly rich material from Gokomere has been published. The distinguishing feature of this ware is in the use made of the comb in its decoration, whether in the rows of dots which usually cover the rim, the horizontal lines with which the necks are often surrounded, or the simple loop designs with which the bodies are decorated. The most popular types appear to have been globular pots with everted rims, often thickened on the outside, and bowls in great variety. In these last the rim is commonly bevelled to the inside, and the face of the bevel decorated with impressions. Of the pieces illustrated, Fig. 1, below, is restored from a sherd found at Zimbabwe by Bent, and now in the South African Museum, and Fig. 2 is a bowl from the Niekerk ruins.

It would appear that the composite walls of the Zimbabwe acropolis are to be correlated with the Sotho period, as no scientific exploration of the red earth filling, which forms the core of the ruin, has been undertaken; but from existing records it is certain that below the upper five feet or so (undoubtedly accumulated during subsequent occupations) only a few iron and copper objects have been found in addition to the pottery; the same can be said regarding the sub-pavement stratum in the Maund ruins.

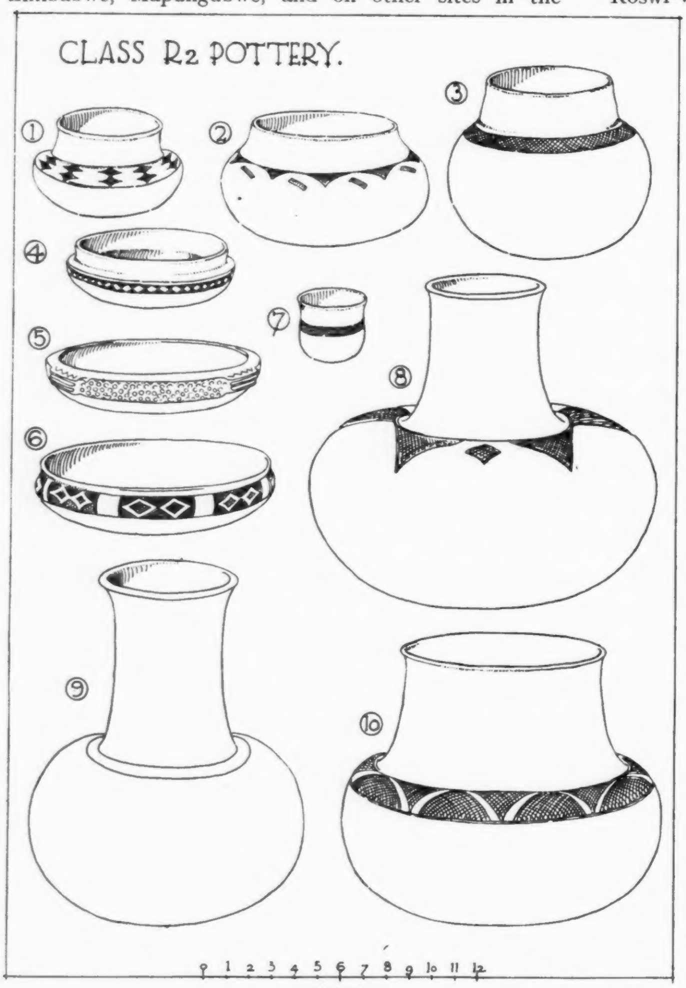
At Parma the sub-pavement stratum, which I associate with the Sotho occupation, yielded ostrich egg-shell beads, and wire bangles of copper and iron. At Gokomere, in a midden deposit seven feet in thickness, sherds of this class of pottery were the only artifacts found, with the exception of a few beads near the upper surface; these beads can be dated with some certainty as being later than 1750 A.D. It is notable that so far no gold has been found in association with this earliest class of pottery. This is, in my opinion, because the gold trade was in an undeveloped state during this period, and as a corollary, the foreign imports of beads used in that trade are also absent from the deeper deposits.

Class R2 pottery must be regarded as being later in date than the R1 ware, at least as far as Zimbabwe is concerned, because it was the predominant pottery found by Caton-Thompson above the original floors in the Maund ruins, where all the R1 pottery found at that level can be attributed to cultural displacement. R2 ware is distinguished by its fine quality and graceful design. The colour varies from a deep black through

grey to a honey colour, the surface being usually burnished. The different types are remarkably homogeneous, for they are all varieties of a single theme. The detail is very similar wherever found, and it is quite impossible to distinguish between pieces from sites as far apart as Zimbabwe and Mapungubwe.

At Zimbabwe this pottery is so intimately connected with the Roswi-Venda material that it is evident that for a time the site was occupied concurrently. At Mapungubwe the case was different, for we found it associated with terrace walling, and entirely divorced from the massive architecture so conspicuous at Zimbabwe.

It is evident that R2 pottery had a wide range, it having been identified in the Gwelo district, at Zimbabwe, Mapungubwe, and on other sites in the Limpopo Valley. In these last its *terminus ad quem* can be fixed by the Venda invasion of the Northern Transvaal, which appears to have taken place about 1750. At Zimbabwe, on the other hand, this pottery tradition existed concurrently with the Roswi-Venda tradition for a considerable period, and we cannot be certain that either held the field independently of the other. We can, however, be certain that no fusion took place between this pottery and the class R1 pottery which preceded it, and, therefore, we may suppose that for an indefinite period Zimbabwe lay desolate. Such a period of desolation would account for the fact that the 16th-century Makalanga knew nothing of the origin of the ruins. I would, therefore, assign this pottery to the 17th and 18th centuries.



This ware usually has a burnished surface, and has fine quality and graceful designs.

Roswi-Venda, or class R3 pottery, has been described by all the investigators of Zimbabwe and other Rhodesian ruins. Bent illustrates fragments of it in " Ruined Cities of Mashonaland," Franklin White found it under the main walls at Khami, and its presence has been recorded at Dhlo-Dhlo, Nanatali, and Regina, and more recently at Haddon, Verdun, Dzata, and other Venda sites in the Northern Transvaal. Its chief characteristic is the use made of polychrome decoration, principally red, black, and buff, the surface of the pots being divided by polished bands of graphite into panels which are coloured or decorated with stippling or hatching. The lines separating the coloured areas were commonly cut on the wet clay, but specimens in which they have been engraved on the pot after burning are not at all infrequent. The chief types used seem to have been globular pots with almost vertical necks and necks decorated with horizontal flutes, simple globular pots, shouldered pots with sharply everted undercut rims, and bowls.

This pottery can be associated with three striking architectural features in the ruins in which it occurs :—(1) The use of structural timber ; (2) the use of decorated walling ; and (3) the use of upright stone posts along the wall crests. All these features are found at Zimbabwe : the two last have been frequently noted, but the occurrence of structural timber, particularly in door-lintels, has not received the attention it deserves, though it was recorded in 1871, and in 1914 Douslin actually discovered portions of wooden lintels in clearing the rubbish from the entrance in the Great

Wall of the western enclosure of the acropolis. In 1903, F. P. Mennell, at that time Curator of the Rhodesia Museum, made a report on Zimbabwe to the Rhodesia Scientific Association, and much of what he said holds good to-day.

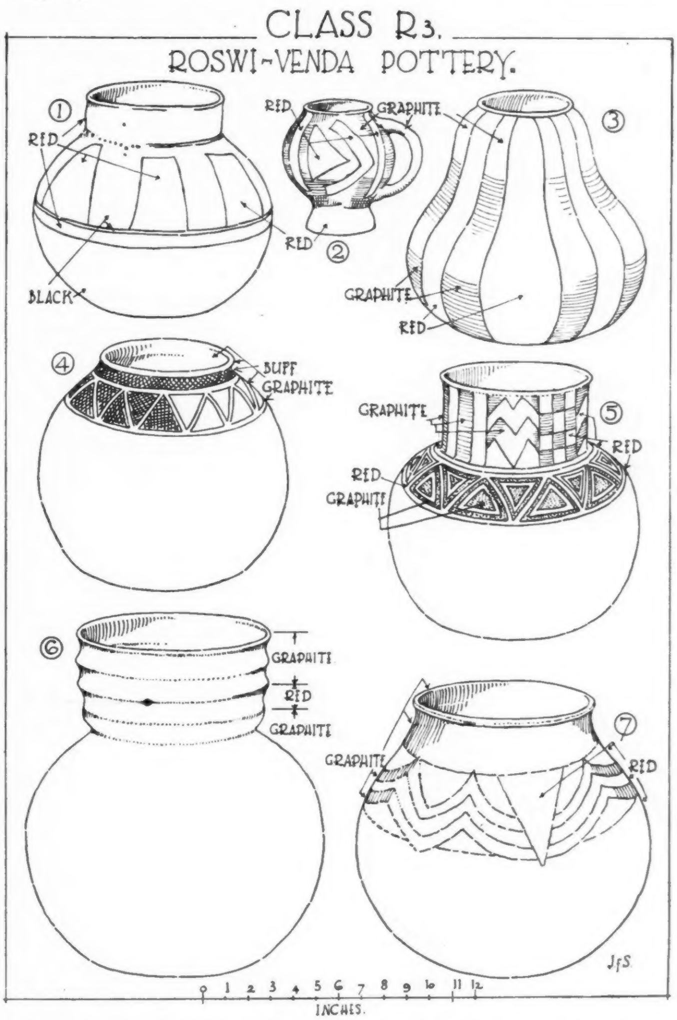
"A passage-way leading up to the highest point of what has always been regarded as the main ruin (of the acropolis) has a stepped recess near the base and there are post holes along the passage, in at least two of which were found vestiges of wooden posts. Mr. Franklin White found similar post holes at Dhlo-Dhlo and recently also at Regina ruins, and in each case remains of wooden posts were discovered. It has been suggested that these wooden posts were not original, but were inserted at a comparatively recent period in place of earlier stone ones. This is, however, mere conjecture, probably arising from doubts as to the probable antiquity of the wood, and even apart from the question as to the likelihood of any one undertaking repairs of the ruins, there is every indication that they have stood from the time the buildings were erected . . . As there seems no reason why the posts, if of stone, should have vanished . . . it appears probable that wood was a material largely employed."

It is significant that timber lintels are still to be seen in the Venda fort at Kanjili, Northern Transvaal, which was erected not earlier than 1860 A.D.

We must also associate the "Zimbabwe Zodiac" with this pottery, for although it was found in a cave some ten miles from Zimbabwe, it is undoubtedly connected with the so-called "ancients," for the crocodile occupying the centre of the dish is precisely similar to the one on the pedestal of a soapstone bird from the acropolis, which is now in the Rhodesia Museum. It seems very likely that the Venda, who unquestionably made and still use these "zodiacs" or divining bowls and tablets, made the soapstone birds also.

We are able to date this R3 pottery with greater precision than either of the other classes from its recorded occurrence at Dhlo-Dhlo, where it was found by MacIver on the surface. Caton-Thompson cut a trench from the upper floor down to bedrock, and found that the decorated external wall rested on a bed of rubble. Directly below this was another floor, on which was found glass and porcelain (to be dated definitely as later than 1700) associated with black undecorated pottery. Below this floor was another bed of rubble, in which a fragment of Class R1 pottery was found, and below this was sand, containing quartz implements, resting on the rock.

Since the lower floor is older than the decorated walling, and as no Roswi-Venda pottery was found on it, we must conclude that our pottery is later than 1700, but as Hall records this ware from "the original floors," it cannot be much later, for the "Zimbabwe pattern" gold work, also from "the original floors," was still current somewhat earlier than 1760. We can, therefore,



Polychrome decoration is the chief feature of this type of pottery.

date our *terminus a quo* to the first quarter of the 18th century. As we have shown elsewhere, the *terminus ad quem* is about 1830 in Southern Rhodesia. In the Northern Transvaal this pottery persisted to an even later date, and finally merges into modern Venda pottery.

The raising of the surface levels of prehistoric sites

due to their occupation by primitive peoples is of world-wide occurrence. In South Africa it commonly takes the form of irregular terracing. At Mapungubwe, for example, it was found that the whole area of the hill site had been covered with soil, in places to a depth of 12 feet, and weighing at least 20 thousand tons, all of which had been carried up the precipitous krantzes with which the place is surrounded and used in the construction of hut emplacements. It is evident that the work had been carried out piecemeal, for in places the differences in level had been adjusted by the use of a rubble infilling, which was brought along its edge to a roughly vertical face of from 4 to 5 feet in height, and which tailed off to nothing amongst the irregularities of the hutting area. It is my contention that, by an analogous process, accentuated by the fact that the original hut area was bounded by a precipice, gave rise to the "composite walls" of the acropolis ruin, and that these walls in turn served as models for the great girdle walls of the western enclosure and elliptical ruin.

The Swazi Invasion

The answer to the second part of the question is to be found in the history of the native races of South Africa. The wars of Shaka set up repercussions in South and Central Africa which lasted from 1820 to 1870, and resulted in the death by battle, massacre, starvation, and cannibalism of at least half the native population of the sub-continent. According to native tradition, the Roswi power was greatly weakened during the first quarter of last century by a succession of bad seasons, which resulted in a severe famine. About 1835 the country was invaded by the Swazi horde; Chirisamuru, the reigning Mambo, was killed, some say skinned alive, and his followers dispersed. A few years later the Matabele arrived under the redoubtable Mzilikazi, and from that time until the British occupation in 1890, the country, now called Mashonaland, was continually raided. The objective of these raids was the capture of slaves, women and cattle; the crops were burnt and the wretched survivors were left to starve in the impregnable fastnesses which became the centres of tribal life. Thus the whole country was depopulated, the towns were laid desolate, and such arts as the people had rapidly decayed, just as they had in Britain fourteen centuries before. Nevertheless, the people did not entirely lose their skill as masons, for Selous could state that the walling he had seen at Umtasa's town was as good as any at Zimbabwe, and the art of fortification did not entirely die away until it became unnecessary under British rule.

How is it that the modern natives have not retained even a tradition to explain Zimbabwe, or any trace of the Zimbabwe ritual in their customs? In point of fact this is not the case, and a number of traditions regarding the ruins have been recorded from Roswi sources. In 1911 Posselt noted an interesting survival of these legends amongst the Nambya, a branch of the Roswi now settled in the Wankie district. These people stated that the neighbouring Bambusi ruins had been erected by them within living memory, and that their forefathers had been organised into the three grades of quarrymen, stone-carriers and masons, in order to carry out the work. It is interesting to note that Bent, in the later editions of "Ruined Cities of Mashonaland," refers to these ruins as being of an undoubted antiquity.

Where are the graves of the teeming populations which once lived on these fertile valleys? There is no reason to suppose that there was ever at any one time a large native population living at Zimbabwe. In my opinion the known facts are more consistent with a relatively small number of people occupying the place over a long period of time. A population of 2,000 could supply all the labour necessary to construct the girdle walls of the elliptical ruin in two years, and as these walls were built in two tiers, this is probably what happened. The soil of Southern Rhodesia is generally lacking in lime, with the result that, except under special circumstances, skeletons are seldom found. It must not be forgotten that the early "explorers" of the ruins were not interested in the collection of skeletons but in gold, and bones without gold were discarded as being of native origin, and quite unworthy of notice.

Graves of the "Ancients"

At Mapungubwe, the only one of these sites that has been examined under scientific conditions, gold was only found either in the graves (of which about 30 have been discovered), or else in positions directly derived from the graves, and I believe that all the gold ever discovered in any South African ruin originally formed part of the contents of a grave. Hall and Neal state that, up to 1901, 40 skeletons of "ancients" had been discovered with an average of $17\frac{1}{2}$ ounces of gold on each. Hall claims to have found another 1,000 ounces of gold subsequently at Zimbabwe, and besides all this, many hundreds, if not thousands of ounces, of which no record remains, were looted. Thus it will be seen that without considering those burials in which gold formed no part of the grave goods, several hundreds of graves have, in fact, been discovered. It is hardly necessary to add that wherever a skeleton from an "ancient" site or mine-working has been scientifically examined, it has proved to be that of an African native.

A further question that arises is, how did the Zimbabwe builders develop a taste for massive architecture and

then forget it? To answer the first part of this question we must make a detailed examination of the acropolis ruin, which is sited on the western end of a prominent granite kopje. The southern face is precipitous for a distance of about 100 yards, along the west and north the slope is steep and has been terraced to a considerable degree while on the east it is overlooked by the central part of the kopje, which in turn shelves down by easy degrees to the surrounding levels. Seen from a distance, the imposing walls on the west and south crowning the impregnable hill crest make a brave show, but on the east and north, where the ground is more favourable to attack, the walls are either absent or consist of terraces constructed for agricultural purposes. It must be inferred, therefore, that although the position lent itself to defence, the principal works were not constructed for defensive purposes at all, for had that been the case the large walls would have been built at the most vunerable points and not along the inaccessible krantzes of the southern face.

How the Walls were Built

The way in which the southern wall of the western enclosure was built can be seen at the point where it has been broken down for a length of about 30 feet. It is evident that the lowest section consists of a wall about 6 feet high and 3 feet wide at the base, which rests on the bare granite. That this wall was built to enclose the original settlement there can be no doubt, for it can be traced wherever the wall can be examined. In the narrow space between this parapet wall and the huge boulders which form the upper part of the kopje, huts were erected, and their remains are still to be seen, including the clay walls, burnt hard and enclosing the charred wattles with which they were supported, and the heaps of grass ashes from the thatched roofs lying tumbled on the clay floors, just as in modern native huts. These huts were burnt down and rebuilt time and again until the levels were raised to such an extent that the parapet wall had to be raised also. This was done by building it back 18 inches on to the hut débris. This process was repeated many times until the débris had risen to a height of about 21 feet above the original level and the wall to a height of 30 feet. This method of wall building, which for want of a better name, I have termed "Composite," can be traced wherever the original walls are accessible for examination. Besides these composite walls we have in the Great West Wall an example of a wall built to its full height as a single structure.

The question as to why the use of cut stone was abandoned for the mud huts of the present-day natives scarcely deserves an answer, for cut stone is quite unknown at Zimbabwe. The surface of the granite formation splits off in great sheets, easily broken up into more or less regular blocks. These were knapped on occasion, but there is nothing approaching stone-cutting. In the Venda building at Maryland, near Messena, I found that the quartzitic sandstone had been dressed into neat cubes, in a manner surpassing anything to be found in the more imposing ruins, yet this is merely a short length of wall which is in no part more than four feet in height. Mud huts form an integral part of all the ruins at Zimbabwe. The walls of the "acropolis" rest on their remains; at the Maund ruins, the walls, which, are amongst the finest in the country, consist entirely of short lengths built between mud huts with which they must be contemporary; in the elliptical ruin, the foundations of these mud huts run under the bases of the main walls, and therefore antedate them.

The Curse of Gold

Why are the ornaments of the modern natives always of iron? In the 16th, 17th and 18th centuries, gold was exceedingly plentiful in Southern Rhodesia, for its exploitation had only just begun, and such things as iron and cattle were more valuable in the eyes of the natives than gold, and, if we are to judge from the quantities found in their graves, gold must have been plentiful in the courts of the Roswi kings.

While discussing this question with the Venda chief Santimule I asked him why his people plated their snuffboxes with lead instead of the gold which their fathers used. He replied that his people found it was impossible to keep gold after the white man came into their country. In a moment of expansiveness an old Lemba smith showed my friend, Mr. Neville Jones, a solid gold bracelet which he had made, and which he usually kept carefully covered up, as, according to him, natives who were seen wearing gold ornaments were often unfortunate. It would appear from Prescott that the Inca rulers of Peru encountered similar difficulties,

Another myth which constantly recurs is the one regarding a chain of forts, connected by a system of roads running from Zimbabwe, by the way of the Sabi River, to the coast. In 1906, H. de Laessoe surveyed the Lundi and the Sabi rivers. He found that there were no ruins at all on either the Lower Lundi or the Sabi, and that the whole route was impracticable in the rainy season owing to the mud, and in the dry season owing to the drought. In 1929 an aerial survey of the Zimbabwe district failed to reveal any line of forts or any trace of ancient roads. Although this myth is constantly being repeated, no stretch of road antedating the European occupation, has up to the present been discovered.

Railway Traction Problems

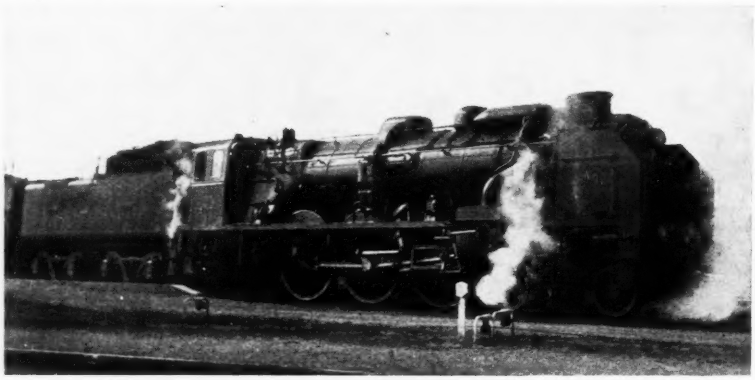
By Lord Monkswell

Until recently the minor factors affecting the performance of locomotives, such as air-resistance, sagging of the permanent way, and the like, have not received due attention. The extent to which these factors apply and the latest advances in countering their effects are here discussed by a distinguished railway authority.

THE question of increasing the efficiency of the machinery used for railway traction may be divided into two sections: the reduction of resistance of the rolling stock so that the power developed by the machinery of traction may have the greatest possible useful effect; and the increase of power developed for each ton of its own weight by the machinery of traction, which for the purpose of this article is assumed to be the steam locomotive.

The resistance due to gravity and that due to acceleration are invariable and can be exactly calculated. A force of 11.2 lb. per ton is always required to overcome the resistance due to gravity of any train running up a gradient of 1 in 200; if the gradient is 1 in 100 the force required is 22.4 lb. per ton, and so on. The energy required to accelerate a train from rest to 10 m.p.h. is always the same per ton-weight of train; that required to accelerate it from rest to 20 m.p.h. is four times as great as that required to accelerate it to 10 m.p.h.; to 30 m.p.h. nine times as great, and so on. Nothing can be done to diminish the resistance due to these causes, but these resistances are fully reversible—that is, to say a train running down a gradient of 1 in 200 is assisted by gravity to exactly the same extent as it is hindered when running up a gradient of 1 in 200, and a train in slowing down from 10 m.p.h. to a stop receives back exactly the same amount of energy as was expended in accelerating it from rest to 10 m.p.h. It is the resistance due to irreversible, or only partly reversible, causes that can be modified if suitable steps are taken.

The principal among these cases are: (*a*) Friction in the bearings, and of rubbing surfaces, of the engine and vehicles. Axle-bearings can be very efficiently lubricated and the resistance due to friction in these parts is small. Friction arises also from the rubbing of flat surfaces such as occurs when the bogies adjust themselves to curves. On the engine in particular practically all the reciprocating parts are exposed to a large amount of friction—pistons against cylinders, piston rods against steam-tight packings, cross-heads against slide-bars, etc. This is one of the reasons why the resistance of an engine is always much greater than that of any other vehicle. Efficient lubrication and the use of metallic steam-tight packings, which permit a small amount of sideways movement, are the principal means of reducing frictional resistance.



One of the reconstructed 4-6-2 engines of the Chemin de Fer du Nord, the performance of which with a 559-ton train is described in this article.

(*b*) Resistance due to the interaction of rolling stock and permanent way. All permanent way yields more or less as the weight of the train comes on to it, and rises again when the last vehicle has passed on. The amount of sinking depends largely on the nature of the subsoil. Apart from this, strong heavy rails fastened to closely spaced sleepers, which are supported in a thick layer of ballast of good quality, will sink less and rise again more quickly than permanent way of inferior quality. A great deal of energy is expended in compressing the road and part of it is restored to the train as the permanent way rises when the last vehicle passes on. (The same kind of action, but of less extent, occurs between the passage of each bogie.) The better the permanent way the less does it sink and the more quickly does it rise again, but in no case does it rise quickly enough to restore to the train all the energy absorbed by compression. This cause of resistance may therefore be described as partly reversible.

In addition to the resistance due to the compression of the road there is always a certain amount of further

Wind resistance did not worry the designer of the old London & South Western Railway locomotive on the right, belonging to the "Jubilee" class (named from its date of construction), and square coaches provided still more resistance. The modern 5X class 4-6-0 of the L. M. S. Railway, which is seen on the left passing Symington with a train of modern smooth-sided stock, slips easily through the air.

resistance due to imperfections in the level of the rails, which give rise to movement of the springs, and consequent consumption of energy in various ways. As the engine is at the head of the train and as it is usually heavier than any other vehicle, it is the engine that performs most of the work of compression. This is another reason why the resistance of the engine is greater than that of other vehicles.

The resistance due to these causes is reduced by making the permanent way as strong, even and resilient as possible. The worst feature in the permanent way is the rail-joint, which on the passage of every wheel invariably gives rise to some small disturbance wasteful of energy. Of late years much longer rails than were formerly used have been adopted, with corresponding reduction in the number of rail-joints. There exists also the rolling friction of the wheels as they roll along the rails. The rolling friction of a steel tire against a steel rail is very small.

(*c*) Air resistance. As the train moves along it displaces some of the air through which it is travelling. Thus in still air the flat surfaces at right angles to the direction of movement must be subject to pressure in cases where they face forwards, and to the retarding effect of suction where they face backwards. In addition to this the sides of the train, even if perfectly smooth, are subject to a small amount of skin friction against the atmosphere. All this is obvious and has been recognised from the earliest times. Till quite recently few attempts have been made to reduce the resistance due to these causes. The front of the engine and the cab have in a few cases been formed with an angle so as to cleave the air, projections on the outside of carriages have been reduced and the spaces between successive passenger carriages have partly been filled by vestibules. But, with trains seldom exceeding a speed of 70 m.p.h., and usually running much slower, the retarding effect of the resistance of still air has been so small that it has not been thought worth while to take any serious trouble about it.

It is well known that if a wind of some strength blows across the line it is likely to increase the resistance of the train. A great deal appears to depend upon the angle at which the wind strikes the train, and even now there is little accurate knowledge on this subject. At one time the reason for the retarding effect of a side wind was believed to be that it pressed the flanges of the wheels against the farther rail, but, although this may sometimes occur, a more general reason seems to be that a side wind increases skin-friction against the side of the train, and if it blows from any forward point making less than a right angle with the direction of the line, it increases resistance. The more projections there are upon the side of the train the greater in all cases is the resistance.

Since trains running at average speeds of well over 60 m.p.h. start to stop have been introduced in various parts of the world the question of reducing air resistance has received a good deal of attention, but it is still at an early stage. One obvious difficulty in the way of streamlining a train is that it is a long, narrow object, with only a very small part of its surface at right angles to the direction in which it is travelling and with very extensive surfaces exposed to a side wind. A certain amount of benefit may be expected from streamlining the front and rear ends and gaps between the vehicles, but with regard to the sides nothing can be done beyond making them as smooth as possible. A further difficulty, to which recent experiments conducted by the L.M.S. Railway have directed attention, is the large proportion of resistance which is offered by the complicated shape of the wheels, axles and underframes—just those parts which can with difficulty and inconvenience be partially

shielded, but to which it is almost impossible to apply effective streamlining.

Nevertheless, certain quite elaborate experiments have been made both on the road and with models in wind-tunnels. The idea which underlies these experiments is that, though it is recognised that streamlining is of little use below 70 m.p.h., above that speed benefit may be expected owing to the real or supposed fact that air resistance against surfaces at right angles to the direction of the wind increases as the square of the speed. Formulæ of this kind should always be received with caution.

Actually the experiments so far carried out appear to show great benefit from such streamlining as has been adopted. This has usually consisted of applying to the engine a covering designed to cleave the air and to shield most of the projections above the level of the cylinders; increasing the height of the tender so as to bring the top approximately level with the engine-cab in front and with the leading vehicle of the train behind; and making the sides of all the carriages as smooth as possible and covering in the gaps between them.

Extravagant Claims.

It is stated in one case that at a speed no higher than 75 m.p.h. a streamlined train has required only three-quarters of the power required for a train similar in all respects except that it was not streamlined. Such a result is on the face of it so improbable that it will be well to suspend judgment till streamlined engines and trains have been running for a much longer time, and much more information is available. It must be added, however, that an advantage claimed for streamlining, unconnected with the reduction of resistance, is that exhaust steam may be lifted so as not to obscure the driver's view ahead. Streamlining will one day be tried on a large scale and then it will become apparent in what circumstances the advantages that it brings outweigh the expense and inconvenience that it causes.

On a strongly built, carefully maintained road in average conditions of weather, and with unstreamlined rolling stock in average condition, the average resistance on a level line of a 12-wheel, six coupled, bogie (4-6-2) locomotive varies from about 27 lb. per ton at 40 m.p.h. to about 48 lb. per ton at 80 m.p.h. The average resistance of large bogie carriages, weighing 50 tons each, varies from about 8 lb. to 12 lb. per ton between similar limits of speed. Smaller bogie carriages have rather higher average resistance. That of tenders is similar to that of carriages, weight for weight.

These figures are only average figures. Actual resistances may easily be anything up to 20 per cent. more or less; and in extreme cases the variation is even greater, often without any apparent reason. I once travelled on an engine, which, with a train of 242 tons behind the tender, required a cut-off of 55 per cent. in the high-pressure cylinders to maintain a speed of 68 m.p.h. on the level. Two days later a similar engine, with 302 tons, maintained almost the same speed in similar weather along the same line with steam cut-off in the high-pressure cylinders at only 42 per cent. Pressure in the boiler of the former engine was maintained at least as well as in that of the latter and the regulator was wide open in both cases.

A Remarkable Run.

Improvements in the steam locomotive, which have already been described in *Discovery* (February, 1936), have made it possible for much higher powers per ton of its own weight to be developed than was the case even ten years ago. A recent example may be set forth: Engine No. 3.1176 of the Chemin de Fer du Nord, one of the reconstructed, 4-6-2 machines taken over from the Paris-Orléans line was working the evening train from Calais to Paris. The train consisted of twelve vehicles, and weighed 559 British tons behind the tender. It was desired to ascend Survilliers bank as fast as possible. This bank begins at kilometre post 48 and extends to kilometre post 28. For the greater part of the way the ascent is 1 in 200, but bits of easier gradient at intervals reduce the average rate of ascent to 1 in 220.

So that there should be plenty of steam a large number of briquettes was put on the fire some ten minutes before the foot of the bank was reached and the ascent was begun at 65 m.p.h. with steam cut off in all four cylinders (two high-pressure and two low-pressure) at 60 per cent. of the piston-stroke and with the regulator wide open. In these conditions 14 kilometres ($8\frac{3}{4}$ miles) were run at the average speed of 66 m.p.h., with hardly any variation. After this there was unfortunately a slack due to an adverse signal, but, if it had not been for this, the same speed could clearly have been maintained to the summit. The scale constructed for these engines shows that the average horse-power developed for the 14 kilometres was in the region of 3,200—about 32 for each ton-weight of engine. It may be added that when the engine reached Paris every bearing was perfectly cool and there were hardly any ashes in the smokebox. The power per ton of engine developed on this occasion is by no means a record. An output of nearly 40 horse-power per ton has been known, but it is improbable that it has been maintained for anything like so long a period.

The Art and Craft of Etching

By Ada Harrison

Etchings, engravings and woodcuts are often confused in the lay mind. In the article which follows the peculiar merits and technique of each are set forth.

THE remark, "I do love etchings," occurs almost as often, in lay exclamations about art, as, "I know nothing about it, but I know what I like." It is applied indifferently to etchings, engravings, woodcuts, lithographs, pen-and-ink drawings, and, in the last extremity, to lino-cuts. It is applied, in fact, to anything black-and-white that appears at a very rough glance to be one of an immense class. It is at all events a sympathetic remark, for it shows the interest commonly felt in things produced partly by extreme skill of the human hand and partly by what is called inspiration. Etchings have another natural appeal for us, inasmuch as they are our most likely artistic acquisitions nowadays, when houses are small, purses, for the most part, tolerably narrow, and taste, compared with that of thirty years ago, austere.

The graver cuts the line. The left hand turns the plate on the sandbag on which the work rests.

All the black-and-white processes have a common denominator, which is what causes them to be lumped together. This is, that they produce not one but numbers of examples of the same thing. They are prints. An engraving and a lino-cut resemble each other very little, but, in the making of each, lines or masses are cut from a surface covered with ink or colour and prints are taken therefrom. What goes to the making of these prints? Take an etching, for example. We look at it first, *in toto*, as a work of art; then, in part, as a far-more-delicate-than-machine-made thing taken by the hand of the artist out of the bare copper. It is fascinating. How does he do it? What did or does Rembrandt, Whistler, Muirhead Bone actually do? The etcher chooses his subject first. Something strikes him that he thinks will make an etching—not an oil-painting or a water-colour drawing, but an etching. Something, according to him, seems to require to be perpetuated in the form of a print, taken from copper, after a certain process, individualised and stamped for the recognition of all by himself. And here let it be emphasised that a thing must be judged according to its medium: an etching must not be judged as an oil-painting any more than a ballet-dancer must be judged as a Rugby-football player; and an etching must not be judged as an engraving any more than a ballet-dancer must be judged as a dancer who dances with bare feet. An engraving on copper, or even on wood, is, compared with an etching, a static thing; the process decides that. It is not the picture of a still object, but it is life taken at a still moment; it gives the whole potentiality of movement, but is not trying to express a moment of movement itself. An etching is intrinsically more dynamic—the medium again decides that—and different things will naturally be attempted in it. The specific and different feeling of and for an etching, engraving, or woodcut, will naturally be got, like all æsthetic knowledge and feeling, only by associating with the things themselves.

The etcher, then, possesses himself of this subject, or, more accurately, the subject possesses itself of the etcher, and he chooses a piece of copper of suitable size. He then makes a drawing of this subject, sometimes highly finished and sometimes rough, and from that a tracing in pencil, a kind of diagram. Next, to protect the surface of the copper, he lays a ground, usually consisting of Burgundy pitch, asphaltum and beeswax. The plate is then heated on a metal heater, a lump of the ground being melted on to the copper and dabbed evenly all over it with a silken pad called a dabber. The ground is smoked over a flame so that the soot becomes incorporated with it and blackens it. When the plate is quite cold, the tracing is transferred to it. This is done by laying the paper face-downwards on the plate and drawing over the lines with a fairly blunt point. Naturally, a reversed image is the result.

The artist now begins his work on the copper. With a steel point he draws his subject, using the tracing as his guide. Each stroke of his needle lays bare the copper beneath the wax. Naturally, he makes the work as elaborate as he pleases. The plate has the appearance of a photographic negative, the dark parts of the design showing as shining copper and the light parts as dark wax. When the artist has put in as much work as he can, his next step is etching the plate. This etching, which gives its name to the process, is the eating away of the copper by immersing the plate in a bath of acid,

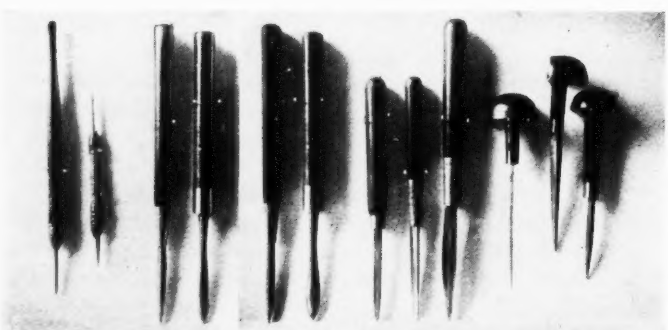
most commonly nitric acid. Before immersion the back of the plate must be varnished to protect it, and now also any mistakes made by the needle must be stopped out with varnish. The length of time the lines are exposed in the acid naturally determines their depth and subsequent blackness. The etcher will choose about three degrees of greyness or blackness of line and bite accordingly, stopping out again with varnish the lines that are sufficiently bitten, so that the acid does not reach them any more. For a light grey he would allow about six minutes in the bath, for a middle grey about fifteen, and for his blacks about thirty. Biting will be seen to be a long process, as the lines which are not to deepen have to be carefully painted out. When the biting is finished the plate is cleaned off, back and front, with turpentine, so that it shows simply as an etched piece of copper. It is now ready for printing.

How the Print is Taken

The necessaries for printing, besides the press, are copper-plate ink, again made according to various recipes, an ink dabber, which is a big pad like a mushroom, printing muslin, a heater, and a wooden box called a jigger, which stands beside the heater, and is of the same height. The plate is put on to the heater, and the ink rubbed all over it with a dabber, the printer using a motion which works the ink into the lines. The plate is next slid on to the jigger, and when it is nearly cold the ink is wiped off it with a pad of the printing muslin. Great care has to be taken to remove only the superfluous ink and not to drag out that in the lines. The final wiping is done with the palm of the hand, for which there is no substitute. The plate is now put on the press, and over it the paper which is to receive the impression. The paper has been previously damped to make it soft. Over the paper go four or five thicknesses of felt called blankets, and the whole is rolled through under enormous pressure.

When the artist examines his work, seeing it for the first time as a positive, he decides what alterations and additions are necessary. To add to the plate he cleans it thoroughly, regrounds it, draws the new work and continues as before. To take away from the plate is not so easy. Mistakes are erased by scraping away the faulty work, which leaves a depression on the surface of the copper. This depression is marked on the back of the plate and the area very carefully beaten up with a repoussé hammer until the working surface of the copper is level again. A little burnishing smooths out the roughness left by the scraper and the restored area is ready for the new work. It is obvious that, of all the delicate processes connected with etching, this erasure is one of the most delicate, and many etchers fight shy of it altogether.

In drypoint and line-engraving no acid is used. In engraving the lines are cut in the copper with a tool. In drypoint, which is a much less laborious process, the lines are scratched with a fine needle, which does not displace the copper but leaves a ridge of it beside the line. This ridge, which is called a burr, holds the ink, and in printing produces the velvety look characteristic of drypoint. The artist naturally needles heavily or lightly to vary the quality of his line, which he can control also by reducing the burr with a scraper so that it holds less ink. The drypoint is printed in exactly the same way as the etching. It will be readily understood that the burr, being raised, will quickly wear, owing to the rubbing and the pressure it receives in printing. To overcome this a fine film of iron is deposited by an electric process on the plate. This is called steel-facing. An unfaced drypoint will yield only four or five first-class impressions before the burr starts to wear. A steel-faced plate will give as many as fifty.



Two etching needles, four burnishers, three scrapers, and three gravers.

Whereas in etching the acid eats away the copper, in engraving the furrow is cut by the tool. Thus, of all processes, engraving has the cleanest line. The furrow is cut by pushing the graver or burin through the copper, a technique which requires a long apprenticeship. In engraving, the plate is grounded and the image transferred to it in the same way as in etching. In drypoint this also can be done, although often the artist begins to needle directly on to the copper. The printing of an engraving is again the same as that of an etching, the chief point being that the plate

should be very fully wiped, to bring out to advantage the clear line.

Wood-engraving is done on a block of boxwood, type-high, as it is called to denote its thickness; and the cutting surface is the end grain of the wood. The tool is a graver, of which there are several forms. Here, again, the cutting is skilled work, although the material offers less resistance than metal. Engraving on wood and metal have this major difference, that the lines that are cut away from the copper are printed black, and the lines or masses that are cut away from the wood remain white. The first is, in fact, an intaglio and the second a surface printing. The image is usually drawn on to the wood in pencil. The line is then cut, its width here, rather than its depth, being significant, as the ink does not enter it. In printing, the surface of the block is inked with a roller, the dry paper laid on to it and the back evenly rubbed with a burnisher or any extempore tool. The printing can also be done in a press. The result is a white line out of a black mass.

Portion of the drypoint "Professor Arthur James Grant" by Malcolm Osborn, R.A. (left), and (right) portion of the line-engraving "Women in Prayer" by Robert Austin. The contrast in technique will be noted.

The woodcut, which is mostly practised by the Japanese, differs from the wood-engraving inasmuch as it is done on the plank and not on the grain of the wood. This again is surface-printing, the masses which are not to be printed being cut away with small gouges and chisels. A woodcut is normally a coloured thing, and each colour demands a separate block, for all the surface has to be cut away except the patches and lines that make one colour. In order to get the colours fitting accurately, prints are taken from the first or key-block and pasted on to each successive block. The colour, which is powder colour with a small quantity of rice flour in it to make it bind, is painted on to the wood with a wide brush. The slightly damped paper is then laid on the block, and is rubbed all over with a special flat pad, covered with a bamboo leaf, called a *baren*. The paper must be a special Japanese make of an absorbent nature.

Owing to the light treatment which it receives in printing, the life of a wood-block is practically infinite. That is, any number of prints can be taken from it. A copper plate, on the other hand, is bound to wear. A normal etched plate will produce fifty prints of equal merit, but the conscientious artist, whether he intends a small edition or a large one, will always have his plate steel-faced to ensure the last print being as good as the first. The same applies to line engraving. If the edition is a large one the steel-facing will wear; it can be removed and a new steel-facing put on.

The word "state," which occurs largely in the language of etching, denotes the stages of the plate as it is being worked to its conclusion. When the artist pulls his proof he sees what has to be altered and what additions have to be made. He carries on until he is content or as nearly content as possible, sometimes achieving his result in a few states and sometimes requiring as many as fifteen or twenty. These states are naturally of great interest to the collector on account of their rarity, as usually only one or two proofs of each are pulled. Etching and engraving imply a copper plate, but actually any metal can be used. The technique is the same for etching on steel, zinc, or iron, but these naturally require a different mordant.

Peculiar Qualities of the Etching

Etching has always had a particular place in the English affections. The atmospheric quality of our light, the grey and subtle affects of our scenery, the individual colour of our soot-coated buildings, all seem to lend themselves peculiarly to expression in black-and-white. There is a great attraction, too, in mastering a delicate and difficult technique, though the mastery of technique can be a danger, if, as sometimes happens, the artist becomes so enamoured of his technical skill as to explore it at the expense of the picture as a whole. But a nice balance, the due submersion of the craft in the art, gives a perfect result and one which makes the folio of etchings, as well as one of the least expensive and most portable, one of the dearest and most satisfying objects of the collector's love.

The Origin of Life on Earth

Tracing the evolution of life back to a first cell does not afford any insuperable difficulty. As to how that cell appeared, however, there are many theories. Below the " purposiveness " and " plain evolution " theories are set forth by different authorities.

The Lamarckian View

By F. W. H. Migeod

A DISCUSSION of the origin of life on the earth is necessarily subordinate to the question of " What is life ? " The best that can be said of it is that it is a phenomenon associated with a particular kind of matter. Life was not always on the earth, for certain conditions are requisite for its occurrence. One of these is a comparatively small range of temperature lying between the maximum and minimum known (roughly between that of boiling and frozen water), and so necessary is water to the occurrence of life, that without it there could be no life. Water, in fact, did not and could not exist on the earth until the cooling of a previously nebular mass had produced some solidity. Then there was a perhaps sudden combination in unequal proportions of two elements, and a new thing, water, came into existence with properties possessed by neither of its component parts.

To account for the beginning of life and the ensuing succession of forms tending towards greater complexity than their predecessors possessed, it would seem that we must be prepared to recognise the new in nature, and not once alone. All through the ages there appear new things as recorded by the rocks. Some may be derivable from other things. Nevertheless there is in each of them a new factor. Many problems attach to the rise of the multitude of living forms, but the two that are of the greatest importance are without doubt the emergence of the new in nature and the motive cause of its emergence. The origin of the various forms of inanimate matter cannot be discussed here. We must, however, I think, be prepared to admit that the cause of one kind of matter must equally be the cause of any other kind, and equally of the forces or functions incorporate therein, though the operating processes may differ.

Let us first consider the composition of living organic matter, after which it may be easier to discuss the origin of the first organism ; for it stands to reason that to try to explain life as an abstraction is no simpler than to explain the origin, say, of light or gravitation or of electricity or, more mysterious still, of crystallisation which is in some ways so akin to life. A living organism is composed of matter, life and mind. Matter seems to us to exist of itself owing to the impossibility of conceiving of its absence ; but mind appears with life. The last two are intimately associated with each other, and it does not seem possible to conceive of the one without the other. The study of atoms has shown that lifeless matter is not entirely in a static condition, there being forces involved in it. The same forces may equally be found in organic matter ; but in whatever kind of matter located they are independent of life and mind. It may be possible to regard matter and life as concepts which can to some extent be understood. Mind, however, is knowable only as regards its subdivisions, not as a whole. Of its existence in all living things there is no doubt. The Amœba, as an example of a one-cell creature, is able to indulge in purposive activities, and intelligence is clearly discernible in both climbing and insect-eating plants.

As to the distribution of mind in the universe : it may be either an external or an internal attribute of matter. In some cases it may be both. It can be said to be external to inorganic matter, and it is also external to all the known forces of nature except one, which is life. Mind, when internal, connotes the existence of life, but since it is external to lifeless matter it can equally be external to organic matter, being thus both within and without an organism. All organisms differ in proportion to the mind quota they embody, and any change in the mind quota entails a different embodiment. When, therefore, the mind quota has been affected by some cause, physical change takes place. Lamarck, whose whole philosophy was based on the psychic in nature, summarised it thus—a new need produces a new habit which produces a new physical character. Accordingly, the origin of all change, of all variation and mutation is assignable to mind, habit being of course a mental product.

Mind must not be regarded solely as intellect. There are other parts such as instincts and emotion, and with instincts, which are the part with which we are most concerned, may be grouped the senses. When one says that it is through mind that an organism takes on change, it must not be thought of as being through that organism's personal intellect. Try as man may with the aid of his considerable intellect, he cannot change the bodily structure assigned to him. On the other hand the lowest organisms with a minimum of intellect can replace parts of their bodies. Where

intellect directly exercised has no place, it is found that other mental parts may be effective workers. With mind as the basis of every organism, if an organism is to be forthcoming to serve as a habitation for any particular mind quota it must be perfectly adapted to the type of mind it has to serve. Every type of mind has its inseparably associated type of body. They are, in fact, symbiotic, and as such every organism is the material expression of a special mind assignment. This mind assignment or quota may consist of as little as a single instinct, though this is doubtful, or of a group of instincts, with in addition a varying degree of intellect. Should there be a variation in the group of instincts, there must necessarily be a physical variation. The position therefore is that a change of mind factor quantitatively or qualitatively implies an accompanying physical change even if that change be microscopic in magnitude and even no more than a change in coloration. In other words a psychic change produces a physical change.

Accordingly, different habits or instincts connote different structure, and as an additional one will cause a new physical character, so the loss of one will cause the degeneration or loss of a character. Instincts seem to have been the first mental attributes assigned to living organisms, and the minimum requirements would seem to be the powers to nourish themselves and to propagate.

The Minimum Requirements

It may be noted that when a habit becomes engrained or remembered in the race it may become an instinct, and these instincts are subsequent to those which cannot be so derived, but seem to appear complete. The latter, the primordial instincts, precede the possession of intelligence, unlike the derived instincts which arising from acquired habits have their origin in some previously assigned intelligence. There must therefore be some point of time subsequent to the appearance of the primordial instincts when the organism acquires a gift of an intellectual germ, subsequent to which, as said, derived instincts can arise. If this be so there would be precluded the possibility of the primordial instincts being based on an intelligence within the organism. To explain their appearance it is necessary to admit the existence of an intelligence external to the organism, that is, of an intelligence that is outside physical space which causes those instincts to come into existence within the organism.

We have now arrived at one reason for assuming the existence of an all-pervading mind in nature, which Lamarck and Haeckel, as well as many other evolutionists, have accepted as necessary to explain the assumption by living things of new characters. Intimately bound up with life as is mind, there can be no such thing as an organism without life and mind, which are essential parts.

Let us now try to view the origin of these complex creatures. The cell is commonly regarded as the foundation of all organisms, and every organism is built up of any number of cells. Some, such as the Amœba, are unicellular; and unicellular forms thus exist at the present day just as they did at the beginning, with life and mind complete and adequate to their maintenance. The first appearance of life may, then, have taken place either in a single cell or in a mass production of cells. If it were a single cell which somehow arrived on this earth, it must either have created itself or have been created. It is difficult to surmise how it could have come into existence of its own volition. It is perhaps easier to believe that it owed its existence to an external agency; and this is the more likely in view of the fact that later forms have through external causes, such as change of environment, acquired characteristics differing from those of their predecessors.

The First Cell

This first cell was something entirely new for the simple reason that it was the first. It would seem that it must have had two attributes or instincts, one to propagate its kind and the other to nourish itself. The locality in which it originated must have been favourable; and this last condition is a very great difficulty. In point of fact the environment could have been hard rock or sand, or the alternative of water absolutely germless. There was in consequence no food for that first cell, unless germless water or germless air or chemicals were all that was necessary, and there could not have been until other cells had originated independently or descended from it. The favourable environment so absolutely necessary seemingly did not exist. Nevertheless the fact remains that if there was a first cell it must have survived in spite of the absence of everything necessary for its survival.

The alternative to the appearance of a solitary first cell is a mass production of cells. This would seem to be more in harmony with the origination of inanimate matter, but an immediate problem is whether they were all identical, or different. If the latter, they would more readily provide the ancestry of the various lines of living foims, and possibly also thereby shorten the length of time demanded by the evolutionary theory. There is one way in which mass origination is helpful. It overcomes a serious difficulty attaching to a theory of origination from a single cell. If that single cell died before propagating itself, it might have had to be

succeeded by possibly many other new creations, until one did survive for the distinct purpose of establishing living things on the as yet barren earth.

In these surmises purposiveness is very much thrust upon us. Since, however, the *how* is no more explicable than the *why*, the problems attaching to multiple origination are not very much simpler than those connected with unicellular origination. In both cases, too, there is the additional problem of whether all this occurred but once on the earth, or was repeated when living things were already widely dispersed; also whether similar occurrences took place in different areas simultaneously, or different areas produced different occurrences. From the foregoing sketch of the position it would seem that, if we are prepared to accept the new in nature, we must be prepared to accept it to any extent both in terms of space and of time.

Whichever way we adopt to explain the advent of living forms and their spread on the earth, the fact remains that the first in the line was composed of life and mind as well as matter. The appearance of a new object where there was nothing before cannot but contain an element of suddenness and, it may be said, also of surprise. When we consider the subject, there is no more explanation that we can really grasp than there is to the *how* and *why* of the origination of inorganic matter, or of its component parts, namely, the once numerous individualistic gases which have combined and consolidated through loss of heat. Yet in all this it seems that purposiveness, as I have said in regard to the first living thing, is a necessary corollary; and, if accepted together with an external intelligence, there is some explanation of an otherwise inexplicable course of events.

The Evolution Theory

By H. H. Barnett

THE working out of evolutionary theories of the development of organisms during the last century leads naturally to an evolutionary theory of the origin of life itself. Professor A. I. Oparin, a Soviet scientist, in a book recently published in Moscow by the Biological-Medical Publishing House, summing up work in this field and attempting to carry it further, rejects the theory that life was carried from some distant planet to the earth. Seeds of life could never have survived the profound cold and vast distances of interstellar space. The radiations that traverse that space alone would have proved fatal, as shown by the deadly effect on micro-organisms of the weak rays that penetrate to the earth's surface.

Clearly, the earth had to acquire living organisms independently. But how? The notion that living beings can be generated spontaneously from dead matter has long been exploded. In the 'sixties of last century, Pasteur proved that living substances cannot arise in an absolutely sterile medium. It is also impossible to imagine the spontaneous appearance of life in the past, in distant geological epochs. Even the most elementary organisms are infinitely complex and could never have arisen suddenly from inert matter. Professor Oparin considers that the solution must be sought along another road, along the road of evolution, of slow and prolonged development from organic compounds, that is compounds containing the element carbon.

All living bodies are made up of carbon and certain other elements. Albumen, without which life is impossible, is a highly complex carbon compound. Life, as a definite form of existence of organic compounds, could only originate when such carbon compounds appeared on the earth. The history of the origin of life is, therefore, first and foremost the history of the appearance and development of organic substances on the earth. But here we are led into a difficult position which many hold to be untenable. There is on earth no carbon or carbon compound which is not indebted for its existence to the action of living organisms. Such organic substances as oil, coal, and so on are the result of plant and animal life in the past.

In other words, for the rise of living bodies we postulate organic compounds, but organic compounds are only found on earth as a result of living bodies. The position is not, however, as untenable as it seems. There may have been epochs when carbon compounds existed which did not arise from living organisms. This hypothesis cannot be proved directly, but there is convincing evidence in its favour. A study of the chemical composition of the stars by spectrum analysis reveals the existence of carbon and carbon compounds, although the high temperatures preclude the possibility of living bodies. Such compounds have also been detected in stars which have an atmosphere that would be fatal to life. Their presence has been observed in our sun. Organic compounds of inorganic origin also exist on the planets of the solar system. For instance, huge masses of the carbon compound methane exist on the planets Jupiter and Saturn.

From these facts, the conclusion may be drawn that it is possible for carbon compounds to exist independently of the existence of living organisms. The com-

binations in which the carbon is found will depend upon the local conditions. The earth, originally formed out of the sun, must have received a stock of carbon. Among the combinations into which this carbon entered during the distant past must have been those with hydrogen, oxygen, and nitrogen. These must have been the earliest organic compounds of inorganic origin. During the course of many million years, more complex substances would have developed, substances which in a number of cases can be obtained artificially in our laboratories. Some, such as albumen, are still only obtained naturally. But there were sufficient time and necessary conditions for the formation of albumen in the vast laboratory of nature.

Simplest Living Thing

The gradual evolution of organic substances must in time have reached a stage when most elementary living substances originated from them. Out of this complex and prolonged process, Professor Oparin selects for emphasis one important stage. Under certain conditions, albuminous substances forming colloidal solutions in sea water must have concentrated at various points and become sharply separated from the surrounding medium. At that stage, the albuminous bodies were not yet living, but already had some of the properties of life. Within them was to be noted a definite structure; they were able to absorb certain matter from the surrounding environment and, as a result of this, to grow. Further, according to Professor Oparin, a peculiar struggle arose among them. Those which possessed the more durable structure had a greater capacity for absorbing substances necessary for their growth. As a result of this struggle for existence, the simplest living being appeared.

A curious point arises here. Originally all living beings fed upon organic compounds at hand. Later there came a shortage of these. For some reason they ceased being formed anew and the existing ones became exhausted. Death by starvation threatened all life. The living bodies solved this problem by developing the capacity to form organic compounds from inorganic. This ability became a characteristic of plants and certain bacteria. Other beings began to feed upon plant life. Professor Oparin rejects the widely held view that the plant type of life preceded the animal type. At one time, all living beings fed upon organic substances, and they retain this property up to the present. Under appropriate conditions it is possible to force plants to feed upon solutions of ready organic substances.

There are in Oparin's theory of the chemical origin of life as outlined above, some obscure points. For example, there is the hypothesis of a period in which there was an amount of organic substances on the earth which later disappeared. The author considers they were unstable and destroyed in the struggle for survival. This is understandable, but it is not clear why these unstable formations altogether ceased to arise. The author does not ask this question, but it naturally suggests itself. The interest of the book cannot, however, be underestimated.

Without chemistry, the problem of the origin of life cannot be solved. Chemistry, however, is not in a condition to solve this question independently. A living being, as Engels correctly pointed out, is the highest unity connecting in one entity mechanics, physics and chemistry. Professor Oparin did not take this truth into consideration. For that reason, his theory is too limited, too narrow. Although there is much in Oparin's theory that is not clear and is of a summary nature, it raises many questions and stimulates further research. The strongest and most positive point in the theory is that on the inorganic origin of organic substances.

Books Received

Battlefield of The Gods. By PAL KELEMEN. (Allen & Unwin. 12*s.* 6*d.*)

The Earlier Letters of Gertrude Bell. Edited by ELSA RICHMOND. (Benn. 15*s.*)

Men Are Like Animals. By DONALD MACPHERSON. (Faber & Faber. 7*s.* 6*d.*)

Evolution Out-of-Doors. By H. J. C. MOLONY. (Hutchinson. 15*s.*)

Adventuring in Coral Seas. By ALBERT F. ELLIS. (Angus & Robertson. 7*s.* 6*d.*)

The Phantom Paradise. By J. H. NIAU. (Angus & Robertson. 7*s.* 6*d.*)

The Wandering Spirit. By RAGNAR NUMELIN. (Macmillan. 20*s.*)

The Quaternary Ice Age. By W. B. WRIGHT. (Macmillan. 25*s.*)

A Simple Study of Flight. By J. D. HADDON. (Pitman. 3*s.* 6*d.*)

Memoir on Australian Fossils of the Late Pre-Cambrian. By SIR T. W. EDGEWORTH DAVID and R. J. TILLYARD. (Angus & Robertson. 3*s.* 6*d.*)

The Petrology of Igneous Rocks. By F. H. HATCH and A. K. WELLS. (New Ed.: Allen & Unwin. 15*s.*)

Cumæan Gates. By W. F. JACKSON KNIGHT. (Blackwell. 7*s.* 6*d.*)

Peary. By W. H. HOBBS. (Macmillan. 25*s.*)

The Vikings of Britain. By D. P. CAPPER. (Allen & Unwin. 7*s.* 6*d.*)

The World in Maps. By W. W. JERVIS. (Philip. 7*s.* 6*d.*)

Logical Syntax of Language. By RUDOLF CARNAP. (Kegan Paul. 12*s.* 6*d.*)

Books and Documents. By JULIUS GRANT. (Grafton. 10*s.* 6*d.*)

Self-Realisation Through Yoga and Mysticism. By JOSEPHINE RANSOM. (Theosophical Publishing House. 1*s.* 6*d.*)

Digestion and Health. By W. B. CANNON. (Secker & Warburg. 6*s.*)

New Practical Chemistry. By N. H. BLACK and J. B. CONANT. (Macmillan. 7*s.* 6*d.*)

The Museums of India. By S. F. MARKHAM and H. HARGREAVES. (Museums Assoc. 5*s.*)

Automatic Weather Reports

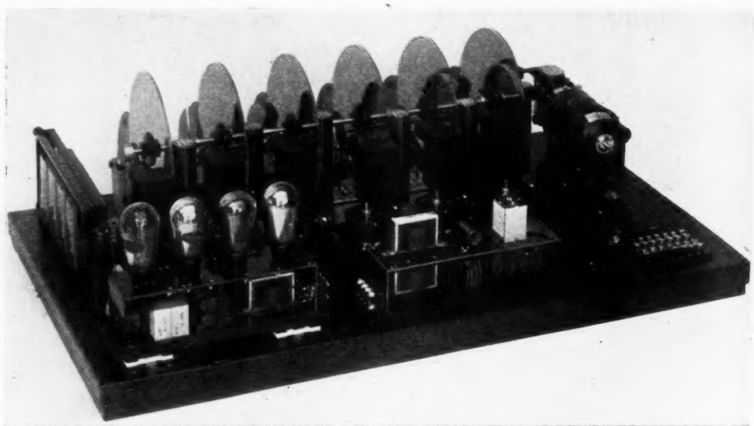
By Dr. Ruth Lang

MACHINES developed by the Swedish firm of L. M. Ericsson have recently been put into service for giving weather forecasts automatically to telephone subscribers on demand. The principle employed is the same as that used in the talking clock, introduced by the Post Office in this country (see *Discovery*, October, 1935). There are six discs, which are shown in the background of the accompanying photograph, each containing a talking film record between two flat circular glass plates. The sound tracks on these discs are arranged in a number of circles. The first disc repeats the days of the week and each circle on the remaining five discs contains phrases, such as "northerly wind; cloudy," etc. On the left-hand side of each disc, as will be seen from the photograph, there is placed what amounts to a small projector, such as is used for showing lantern slides. The beam of light from each of these shines through one of the discs on to a photocell on the other side of the disc, which converts the fluctuations of the light caused by the intervening film record into corresponding electrical signals. The action is precisely the same as that employed in talking films. The electric pulsations are amplified in the usual way by means of a suitable radio amplifier, the valves and other parts of which will be seen in the front of the photograph. The amplified electric signal is transmitted to the subscriber and converted into sound in the earpiece of his telephone.

Setting the Machine

In order to set the machine, each projector with its corresponding photocell is moved across the radius of the disc which it serves until the beam shines through the circle containing the phrase selected for the day. When the machine is running, the day of the week chosen from the first disc is signalled first, and this is immediately followed by one of the phrases selected from the second disc, and then by one from the third disc and so on. A subscriber will thus receive a message, such as the following: "Monday; decreasing; westerly wind; cloudy; mainly fair; warmer," each phrase being chosen from one of the six discs. By placing the projector with its accompanying photocell opposite a clear part of a disc, the phrases on this disc are entirely missed, a practice which is sometimes required.

The first machine of this kind in the world was installed in Stockholm in June, 1936, and the second at Stavanger in August. Its usefulness is demonstrated by the fact that, between July and August, up to 15,000 calls a day were dealt with by the Stockholm machine. It is interesting to note that it has recently been announced that the time-giving machine installed in London by the Post Office is already producing a revenue of some £50,000 per annum. The possibility of employing a weather report machine in this country is understood to be under consideration.



A step beyond the telephonic clock: the Ericsson automatic weather reporter, which has already won great popularity in Sweden.

New Relay Device

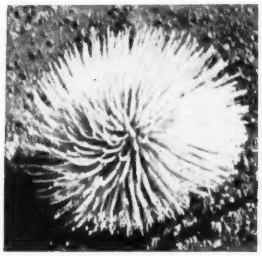
A very modern invention is the "Corpatact," an electrical device, consisting of a capacity-operated relay which can be used for lighting lamps, starting motors, etc., by a human body coming within a predetermined distance—the body itself creating contact. For instance, the act of a person walking up to a window immediately floods it with light, the light again being extinguished by the person moving away. The "Corpatact" advertising mirror sign appears to be an ordinary mirror until one looks into it—then the mirror becomes transparent, revealing only the advertisement. The "Corpatact" burglar alarm is entirely different from any other. The safe or strong-room is protected from any angle, even through a wall. These devices can now be obtained direct from the manufacturer and patentee, the Corpatact Manufacturing Company of Iver, Bucks.

Silverswords of Hawaii

By a Special Correspondent

Not the least puzzling of the specialised animal and plant species of the Hawaiian Islands is the six-foot Silversword flower, which inhabits extinct craters on only two islands.

ONE of the rarest plants in the world is the Hawaiian Silversword. This plant is a native of the high mountains, the largest species, *Argyroxiphium sandwicense*, being confined to the slopes above 7,000 feet on Mauna Loa, Mauna Kea, and Hualalai, on the Island of Hawaii, and to Haleakala on Maui. The first two peaks mentioned rise to nearly 14,000 feet.



A young silversword plant.

The crater of Haleakala, home of the large silversword, is a most awe-inspiring sight. It is familiar to geologists as being the largest crater in the world, with a circumference approaching 20 miles. One climbs a mountain nearly 10,000 feet high to look into the immense crater, of which the floor and precipitous walls 2,000 feet deep, are composed of blackest lava. Within it are several lesser cinder cones that show practically no sign of erosion. These cones are not old, geologically speaking, although the peak has shown no volcanic activity since about 1750. Their remarkable preservation is due to the fact that scarcely any rain falls within the crater, and its cinder fields are a virtual desert. The silversword is among the very few plant inhabitants of this arid lava bed.

On none of the four peaks is it abundant, and it is possible that the eruption of Mauna Loa, in November, 1935, killed off stretches of this rarity. It is exceptionally beautiful in all stages of growth, from the young silvery spheres two feet in diameter to the flowering forms that shoot up with their hundreds of heads to a height of three to six feet. The plant gets its name of silversword from the rapier-like leaves that are densely coated with a lustrous white wool. The young rosettes of the plant are composed of hundreds of these gracefully curved but rigid leaves that form a dense, silvery sphere. The woolly covering reflects part of the intense sunlight under which the plants live. The rosettes grow for a number of years before sending up a single flowering stalk, after which they die.

Flowering occurs from June until October. The heads themselves add little to the colour of the plant, with their small, yellowish disc-flowers and rather inconspicuous purplish ray-flowers. The native Hawaiians knew the plant and called it "ahinahina," which may be translated "grey-headed." In the early days the tourists who visited the crater of Haleakala were accustomed to uproot the largest specimens merely to watch them roll down the slopes like huge snowballs. Quantities also were ruthlessly gathered and shipped to the Orient as ornaments. These practices have long since been stopped and the plants are now under protection, as the species was facing extinction. Several insects are injurious to these plants, in particular a moth and a grey fly, whose larvæ feed in the developing heads and destroy most of the flowers before they can produce seed.

Both Haleakala and Mauna Loa are now included in Hawaii National Park and the park authorities have taken measures to conserve the silversword. Flowering specimens have been protected by cheesecloth coverings from attack by insect enemies, and seed has been gathered and resown. Recently, hundreds of plants have been raised in a federal nursery for distribution among the residents of other sections of the Islands.

Five Species

In marked contrast to the large silversword which grows on the arid alpine slopes, two other species of *Argyroxiphium* are found on the summits of two much lower peaks on the Island of Maui, where the precipitation is exceedingly high. In fact, these plants grow in boggy areas that are kept continually wet by precipitation and fog. A fourth species, the greensword, so named because it lacks the silvery pubescence, is even rarer than the silversword, being confined to the region of Haleakala, on Maui. In all, five species of *Argyroxiphium* are recognised. Three of these, including the silversword and greensword, bear their rosettes of leaves at ground level. But the remaining two species are rosette-trees, with the leaves aggregated at the summit of an erect woody trunk.

One of these rosette-trees grows on the above-mentioned boggy mountain-tops in Maui. The other is confined to Kauai, the westernmost of the larger islands in the archipelago, and it is somewhat removed from other species of *Argyroxiphium* in botanical characters.

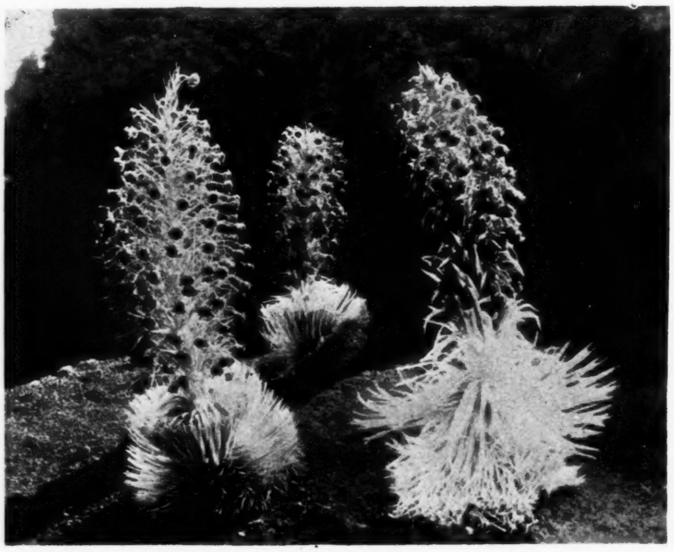
As North America is the continent nearest to Hawaii,

one might expect a preponderance of American types in the flora, particularly since such agencies of dispersal as the northeast trade winds, migratory birds, and ocean currents are active from the continent to the Islands. On the contrary, most botanists agree that the great weight of plant evidence favours a Polynesian-Australian and Indo-Malaysian origin for almost all of the Hawaiian flora. There is a very real relationship between the floras of New Zealand and Australia, and of the Hawaiian Islands.

A report by Dr. David D. Keck on some of the Hawaiian tree-Compositæ, particularly the genus *Argyroxiphium*, has recently appeared in a publication of the Bernice P. Bishop Museum, of Honolulu. It is shown that the few cases of very old and exclusively Hawaiian genera previously thought to be of New World origin are very doubtfully so. Therefore, it is questionable whether or not any of the early arrivals in the Hawaiian flora came from America. Rather, it seems probable that the first vegetation of the Islands was composed of species brought together from Pacific lands to the south and west and that it consisted of plants whose seeds were carried there either by ocean currents, cyclonic winds, or animal agencies such as migratory birds.

A very insignificant element in the Hawaiian flora consists of genera with species found both on the Islands and in America. But these obviously appear to be much younger than the genera which are peculiar to the archipelago and are thought to have arrived in the Islands since the Pleistocene period. It has long been suspected that the Antarctic Continent must have supported a flourishing flora as recently as early Tertiary times at least, and was probably connected both with Australia and South America.

Botanists explain the obvious similarities and relationships between the floras of southern South America and Australia and New Zealand on the assumption that a migration route between them was available to plants for a long period of time. Supposed remnants of that early flora are found at several points in the Southern Hemisphere and it is a possibility that the ancestors of the olders elements in the Pacific flora emigrated from that southern region, among them the forerunners of these arborescent Compositæ.



Silversword plants growing in the crater of Haleakala, Hawaii.

Problem of Ancestry

Several species of the Compositæ classified as the *Madinæ* are known locally in Pacific Coast states as "tarweed," and the silverswords were thought at one time to belong to this group. The *Madinæ* otherwise are confined to the west coast of the United States and adjacent borders, with the exception of two species which range from Central Chile and Argentina to Patagonia. The South American representatives are very similar to some North American species, and consequently may be considered comparatively recent immigrants from North America.

It has recently been proved, however, that the silverswords of Hawaii have no close affinity with the other species of the group, and are not rightly to be considered members of the *Madinæ* at all. On the other hand, they have connections with other arborescent Compositæ of the Islands, and the evidence is that all these species taken as a unit originated in lands to the south or south-west of Hawaii in the Pacific.

In view of the interest attaching to this species, and its value in aiding investigators in tracing the "immigration routes" of plants it is good to know that measures for the protection of the silverswords have been taken. It is a proof of the innate hardiness of the plant that even in the crater, where the soil consists solely of cinders, it managed to survive both the sustained attack of insects and the depredations of tourists and commercial exploiters.

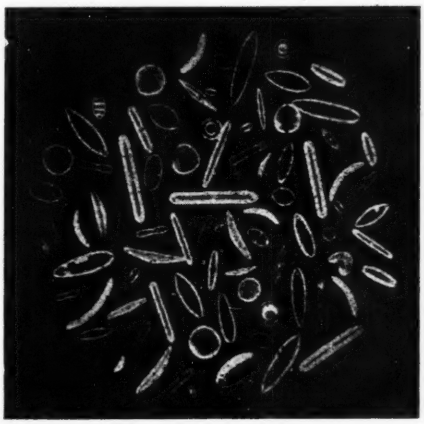
Thanks are due to the Carnegie Institution of Washington for permission to use the two photographs of the silversword.

Diatomaceous Earth

By Kenneth Tomlinson.

The human race is indefatigable in its search for products of nature which it can turn to advantage, and here is described an industry thriving upon a deposit of skeletons of some of the first organisms to appear in the world.

ONE does not readily associate the Lake District with the chemical industry, but at Kentmere, a little valley tucked away in the hills about six miles from Windermere, there is a source of a very useful and a rather uncommon product. The Kentmere valley, as its name implies, was once a small lake, in fact it was only during the last century that it was drained to increase pasture land. In the lake, conditions were exactly suited to the development of a species of marine algæ, known as diatoms. These diatoms are unicellular, free-swimming plants, the cell walls of which have beautiful and intricate designs. At Kentmere 90 different specimens have been found, each one having a distinct geometrical pattern. These diatoms multiply very quickly, and as they die their remains accumulate on the lake bottoms and form deposits of what is known as diatomaceous earth. This action takes time, of course, and at Kentmere, a lake formed in the glacial period has left a main deposit 900 by 300 yards in area, and upwards of 20 feet deep. The material consists of the small siliceous skeletons of the diatoms, mixed with some organic matter and a trace of iron. The actual skeletons are hydrated silica, which is white, but owing to the presence of organic matter, diatomaceous earth in most deposits is dark brown and spongy. At Kentmere the earth darkens on exposure to air, the final material being a dark-brown fibrous substance, very like fine soil in appearance. The colour change to dark brown is no doubt due to the slow oxidation of the iron present from the ferrous to the ferric state.



Kentmere diatoms

The impurities, iron and organic matter, are easily removed. Steaming with strong sulphuric or hydrochloric acid converts the iron into soluble salts which may be washed out of the solid. Actually this operation is rendered difficult by the fact that the earth retains a large bulk of water; while, owing to its lightness, it will not settle out, and because of the microscopic size of the diatoms, a suspension of the earth in water is very slow to filter. Having removed the iron, strong heating in a furnace will decompose the organic matter and burn away the resulting carbon. During the decomposition, condensation of the vapours evolved produces a brown liquid, which contains some acetic acid and compounds of a tarry nature. The liquid is very similar to pyroligneous acid obtained by the distillation of wood, but it is more dilute as one would expect, since the earth, when dug out, contains over 60 per cent. of water. Above 500°-700° C. the water of hydration of the silica is driven off, and the material left is a very fine white powder, which should be nearly pure silica.

Owing to its rather peculiar structure, diatomaceous earth has an amazing variety of uses in industry. Since it is composed of small skeletons there are tiny air pockets trapped in the material, so that while the density of silica is 2.1, the apparent density of diatomite is 0.45. Upon this fact rest two important uses. First, the material is extremely porous and can absorb about five times its own weight of water. For this reason it is used as an absorbent for nitroglycerine in dynamite, and for dangerous liquids, such as bromine and sulphuric acid. Second, owing to the minute air spaces in the material, it is a very efficient heat, sound, and electricity insulator. It is used for packing boilers and steam pipes to prevent heat losses, in fireproof bricks, and in refrigerators. A further advantage in this connection is that diatomite has an extremely low coefficient of expansion. As a sound insulator it is used to pack the walls of rooms, and when incorporated with resins, for which it acts as a binding material, it is used in the manufacture of electric light fittings.

These uses by no means exhaust all the possibilities. Chemically, after dehydration, it is pure silica with a melting point about 1,600° C., i.e., well above the range of temperature likely to be met in industry. It is very inert, and is attacked only by hydrofluoric acid and by strong caustic alkalis to give the corresponding silicates. Consequently, it can be used as a filtration medium

for almost any chemical from mineral acids to oils, fats, wines, sugar solutions and the like. Filtration through so fine a medium not only removes all suspended matter but also has some bleaching action. For use in connection with foodstuffs the material must be free from poisonous impurities, and, fortunately, the Kentmere deposit contains neither lead nor arsenic. It would be interesting to know in this connection whether the pore size is sufficiently small to prevent the passage of bacteria during filtration.

Two other very important uses depend on the absorptive properties of diatomite, and the fineness of its state of division. For various catalytic processes the surface area of the catalyst contributes very largely to the success of the process, and it is found that, when deposited on diatomite, a catalyst has a larger effective area than when used by itself. For this reason nickel deposited on diatomite is used as a catalyst in the hardening of unsaturated fats by hydrogenation. Most finely divided materials of an earthy nature have some detergent effect, partly because they suspend well in water and do not settle out, and partly because such substances absorb fine particles of dirt. For this reason diatomite is used as a component of some detergent mixtures and as a "filler" for soaps, and it possesses an advantage over the clays since it has a considerable abrasive action.

Other important uses of diatomite depend on the fact that the tiny skeletons, of which the earth is composed, have sharp edges even when broken, and so the earth is an excellent component of abrasive powders and metal polishes and is familiar to every housewife in this connection. For the same reason a finer variety is used in tooth pastes and powders to replace chalk or magnesium carbonate. As a filling and binding material diatomaceous earth finds extensive applications. Rubber, paper, gramophone records, cement, putty—all may contain it with advantage. The pure substance may be used as a source of silica for the manufacture of such substances as ultramarine, and here again the fine state of division makes it more suitable than other forms of silica for chemical reactions. Owing to its lightness, and because it has not a very great covering power, it is little used in paints, but it comes into its own again in the field of cosmetics where, mixed with other materials, it is used in face powders and nail polishes. Here the absorptive properties are invaluable since the powder will hold a liquid perfume and still remain dry. Diatomite is probably the world's most versatile chemical product, and in many ways the most interesting. It is an amusing commentary on our civilisation that for many of our major industries we have to depend on the skeletons of small marine plants which cannot be very far removed from our first ancestors.

The deposit at Kentmere has only recently been developed and it promises to be a rich field. There are few deposits in Great Britain, and the bulk of the material used in this country comes from Germany and the United States. In both of these countries the deposits are free from organic matter, and mining and purifying the material is a comparatively easy matter. Possibly because of this, the potentialities of this rather remarkable substance have been more widely appreciated abroad than in this country.

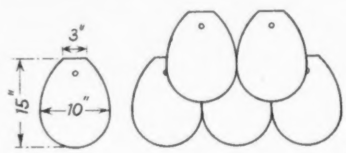
[The Author's thanks are due to J. T. Browne, Esq., Director of Kencert Products, Ltd., for much of the information given in this article.]

Correspondence

NEW TYPE OF ROMAN ROOF TILE

To the Editor of DISCOVERY.

Sir,—In *Discovery*, September, 1936, I described a Roman tilery at Ewhurst, Surrey, and its product. One interesting "find" escaped me, of which Mr. R. Goodchild, who took away the fragments for closer examination, has sent me word. These a few pieces of Roman roof tiles which I believe are unique: I have never seen such tiles before, and can find no reference to them in such books as those of Ward, Lethaby, and Collingwood, or in archæological reports. The nearest known type is the fairly common hexagonal stone slab. But our tiles are of red burnt clay, and pear-shaped, with nail-holes at the top. They are one inch thick, about fifteen inches long, ten inches at the broadest and three inches at the top. The usual heavy flanged tiles (tegulae) and half-cylindrical tiles (imbrices) had not nail-holes: their weight kept them in position on low-pitched roofs. These lighter nail-hole tiles, however, were probably intended for the higher-pitched ornamental roof of a building of some architectural pretension, possibly a temple. The sketch shows the shape of a tile and the obvious method of laying. Can some reader of *Discovery* quote similar examples?



The newly discovered tiles, possibly unique in England.

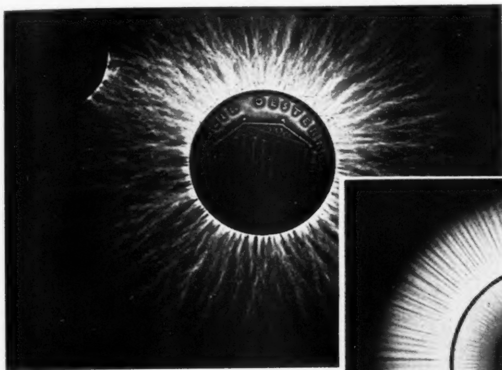
Yours faithfully,

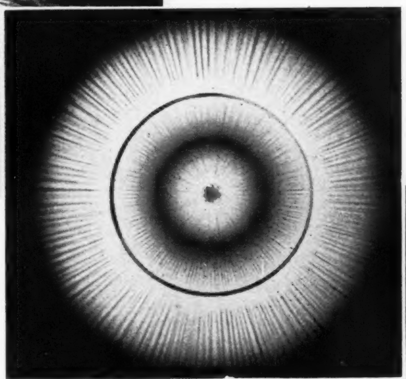
Horsham, Sussex. S. E. WINBOLT.

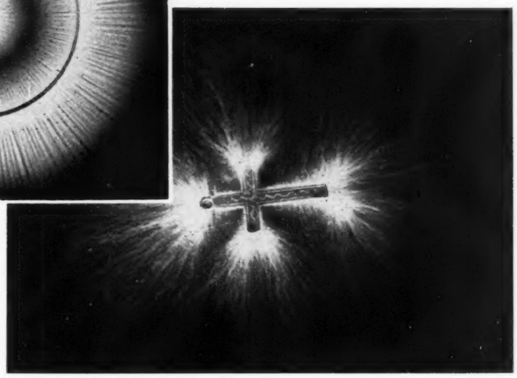
The National Trust is seeking parliamentary powers to extend its mandate, with the approval of the Tynwald, over the Isle of Man. The immediate object of this move is the acquisition of the Calf of Man, the islet at the south end of the main island, as a nature sanctuary, an advantageous offer having been made. The sanctuary would be supervised by a committee of prominent Manxmen, and would be closed during the nesting season.

Direct Electric Photography

At the University of Vienna experiments have been successfully carried out to photograph objects direct, with no camera or other apparatus, simply by the use of very high electrical voltage. Potentials of 100,000 to 250,000 were employed. The force of the current was so terrific that in the early attempts, even though the flash lasted only a very small fraction of a second, the negative plate was fused. By experimenting with insulating materials this obstacle was overcome, and good photographic prints were eventually obtained. Three typical examples are shown below. Points which should be noted are the perfect symmetry of the centre picture, and the sharp definition of that on the left.







Above, an Austrian schilling photographed under 200,000 volts. The coin was laid on the insulated negative plate and the flash directed on to it. The upper surface is photographed right through the metal.

Centre, a serviette ring photographed direct on to the negative plate with a flash of 100,000 volts.

Right, a gold cross under a pressure of 250,000 volts.

Photography and Science

A concentrated and comprehensive talk on "Applications of Photography to Scientific and Technical Problems" was given before an overflowing meeting of the Royal Society of Arts on February 10th by Dr. Olaf Bloch, Head of the Ilford Research Laboratories.

He began by showing that a photograph of sufficiently long exposure would register a star of the 21st magnitude, showed some photographic determinations of the velocity-distance ratio of extra-galactic nebulæ, evidence of carbon dioxide in Venus, and other spectra, continued with X-ray photographs of culture pearls and a picture taken through six inches of steel by using gamma rays, and then passed on to photomicrography.

He dealt at some length with the Edgerton High Speed Camera, in which the film flashes past the focal field at 200 ft. per sec. A spark and mercury-vapour illumination apparatus would give up to 6,000 flashes per second, and thus in combination form a high-power stroboscope. Among high-speed photographs shown was one of a pigeon in flight taken at 1/100,000 sec.

Spark photography was touched upon, and a stroboscope film was shown. This included a cat falling on its feet after being dropped upside down from a height of two feet, and a fly righting itself after being flicked off a card. The latter incident took 1/10th sec. of the fly's time, but was slowed down to one minute on the film.

Mr. Bloch then issued a challenge that his Ilford assistants who were present could take a photograph of the Chairman (Dr. D. A. Spencer, President of the Royal Photographic Society), and produce a lantern slide in one minute. With a green safe-light turned on a stop-clock, the photograph was developed, fixed, reversed in acid bichromate, and rinsed in 55 seconds. Then it was pressed between glass and sent up to the lantern. As a perfect portrait of the Chairman flashed on the screen there was a roar of applause. "We get faster and faster," said Dr. Bloch, "but—*cui bono.*"

Optical Lenses from Plastics

One of the exhibits at the Olympia Section of the British Industries Fair is a series of optical lenses made out of a plastic substance by a patent moulding process. These lenses are claimed to be as good as or better than glass. They are not affected by the ordinary temperature range, and are resistant to acid. The material is lighter than glass, and can be prepared with various refractive indices. A representative of DISCOVERY examined the lenses at the offices of Combined Optical Industries, Ltd., who are marketing the lenses, and found them quite unbreakable and unscratchable. The photographs taken with the lens showed unusual depth of focus, probably owing to the fact that this material passes about 30 per cent. more ultra-violet than glass. It is understood that the moulds can turn out 100 per cent. good lenses, needing no polishing, and will last for many years, turning out one lens every few seconds. The advantages of the invention in particular fields should prove striking. Owing to the great saving of time and expense in grinding and polishing it will be possible to reduce the cost of lenses and materials. Schools or research institutions which are not well provided financially and which up to the present have been unable to maintain well-equipped laboratories will have new opportunities. Television mirror drums and other optical systems in television apparatus can be easily made by this process, where it is extremely difficult and costly to obtain the necessary result with glass.

The March of Knowledge

Platinum. After ten years of research, Mr. John Eklund has just successfully completed large-scale experiments for recovering platinum from the most difficult Northern Transvaal ores, which have hitherto defied every ordinary method of extraction on a commercial scale. Mr. Eklund claims extraction of 88 per cent. at a cost of 5s. per ton by means of his new chemical treatment. Steps are now being taken to test the process on a full commercial scale. If the expected success is achieved, South Africa will become the world's greatest platinum producer, for even if the price fell to £4 sterling an ounce, Mr. Eklund claims that his process could still be profitably employed.

Railway Sheepdogs. Licences have just been taken out for twenty-five sheepdogs by the Great Western Railway, who employ them to assist the ganger in keeping certain of the Valley lines in the Cardiff, Neath, Newport, and Oswestry Divisions clear of straying sheep. The sheep descend from the surrounding hills and find their way through the fences into the railway cuttings in search of pasture and endanger their own lives and cause delays to trains.

Sausage Vans. The sausage is the latest commodity for which the Great Western Railway has designed and constructed special vehicles. Two insulated vans have just been built at the Company's Works. Each has six wheels, is vacuum fitted and fully equipped for working on fast passenger trains. The bodies are 31 feet long and eight feet wide and the roof, sides, end, and floor are insulated with cork to a thickness of two inches. The walls are lined with a hygienic covering and the floors with a fireproof material.

Roman Fort. A special exhibition in the Prehistoric Room of the British Museum illustrates last year's excavations in the great fort on Eddisbury Hill in central Cheshire. The work showed that the defences were built in the pre-Roman Iron Age, perhaps not very long before the Romans established their legionary fortress at Chester. In the Roman period, however, this native stronghold, which threatened the road between Chester and Manchester, was dismantled by the new rulers of Britain, the ditch being filled in and lengths of the ramparts being destroyed. Subsequently, native squatters returned to the site and lived in huts amid the ruins of the camp, and finally, some Anglo-Saxon built a hut on the filled-up surface of the ditch.

Unique Mummy. A young British archæologist, Mr. Walter Emery, has discovered the only body of a noble of the First Dynasty of Egypt yet found, at Sakkara, almost within sight of the step pyramid of Zoser. The body is that of Sabu, Governor of the Province, under King Azab, the fifth ruler of the First Dynasty. With the body (which had been decapitated by robbers) was an unique schist vase shaped like the steering wheel of a motor-car and of about the same size. The tomb dates back to about 3200 B.C.

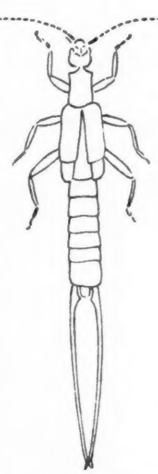
Arsenic Brass. Recent archæological researches have discovered in Egypt, Cyprus, and Peru, a number of brass weapons of great antiquity in which copper is alloyed with arsenic to the extent of 1.35 to 5.30 per cent. Similar ancient utensils have been found in Germany, and German chemists are investigating the possibility of substituting arsenic for tin (which is rare in Germany) in a new brass alloy. The ancient armourers, of course, had no suspicion of the presence of metallic arsenic in the weapons that they manufactured.

Earwig Lore

By Malcolm Burr

That earwigs are good mothers is the only favourable thing most people have to say about these creatures; but Dr. Burr shows in the article below that for all their repulsiveness they are full of interest.

EARWIGS are universally disliked and often feared, but they merit attention because they are of ancient lineage and of great interest both in structure and habits. In one important particular they are almost unique among insects, in the care and attention which the mothers devote not only to their eggs, but to the young after they are hatched. Baron de Geer noticed this as long ago as 1759, and his observations have often been verified since. Worthington has found the curious fact that in this country they pair in the winter, retiring to their nests, which are usually little galleries excavated by themselves in earth under a stone, or in a hole made by another insect, or similar suitable cranny. They appear to live together in pairs for several weeks, until the mother starts laying her eggs, early in the new year. The males are then expelled, or at least leave the nest, and in the spring are to be found in numbers, living a bachelor existence until they die off in the early summer. Meanwhile, the females brood over the young larvæ, it seems at least until the first moult, dying themselves early in the summer, by which time the larvæ are half grown. It is when the young generation attains maturity in the later summer, about August, that they start investigating the world, and so obtrude themselves upon the notice of humans.



Auchenomus longiforceps Karsch.

This life cycle is not only remarkable in itself, but in its season, for earwigs are active at the time of year when in Britain almost all insects are dormant, either hibernating or passing the winter in the egg stage. A surprising point was noticed by Worthington, that the mother turns her eggs over every day, and cleans them. If she is prevented from doing this, the majority of the eggs become mouldy. There is here a connection with a vital factor in the existence of the order, that they are hygrophilous and flourish in damp situations and humid climates. The same thing has been noticed in the Russian earwig, *Forficula tomis* Kol., whose habits resemble those of our own common species, except that she lays her eggs in the spring. A Russian writer, Pesotskaya, has observed that the mother does not neglect her eggs for a moment, constantly examining them, moving them from spot to spot, and, as it were, licking them over. When the mother was removed from the eggs, 90 per cent. of them became mildewed.

That this habit runs right through the order is shown by an observation by E. Ernest Green in Ceylon, on *Diplatys Greeni*, which remains constantly near her eggs, visiting each in turn, and, it is interesting to note, "mouthing them in a peculiar manner, as if to keep them clean." The subfamily *Diplatyinæ* is one of the most primitive of the order, at the lowest end of the scale, where our familiar genus *Forficula* is at the highest. Another result of the maternal care is the protection of the ova and young larvæ from the attacks of grown male earwigs, which would suggest an explanation for their expulsion from the nest by the mothers.

It is interesting to note that our common earwig, *Forficula auricularia L.*, in Russia has the same life cycle as with us, that is, it passes the winter in the egg and imago stage, while the stronger, purely Russian *F. tomis* passes the winter in the larval stage. Xambeu noticed that the mother mountain earwig, *Chelidura pyrenaica*, continues her solicitude after the young are hatched. He describes how she leads them out, as a hen leads her chicks, to places where they will find food. As soon as the young are strong enough to be able to look after themselves, the mother abandons them. They then disperse, a necessary habit owing to their insatiable habits and undoubted carnivorous propensities.

The most noticeable thing about an earwig is its forceps. These inspire dread in the minds of the superstitious, and it is this instrument at the end of their sinuous body and their habit of bolting into dark holes and crevices that has led to the widespread notion that they are apt to enter the human ear and penetrate to the brain with fatal results. From this belief arose our familiar name, which appears first in Anglo-Saxon as *earewicga*, the second half of which is from an old verb which survives in the words wiggle, waggle, wriggle, meaning quick movement. There is no ground for fear. Earwigs may seek refuge in a human ear, as at times

do other insects, especially of a man asleep upon the ground. But the insect has no poison gland, the forceps are merely horny, and can only nip. Besides, a drop of oil will at once wash the bewildered creature out. For their nip to be perceptible to a human being, it must be on a tender piece of skin, but those forceps must be formidable weapons to creatures their own size. The biggest earwig I have ever seen was a huge female of *Titanolabis colossea* (Dohrn.), from New South Wales, in my collection. She measured no less than 66 mm. in length, that is almost two and three quarter inches. Commander Walker, who knew this species well, told me that its nip was strong enough to pierce the skin and draw a drop of blood from the human finger.

Earwigs use their forceps for many purposes. Green has noticed in Ceylon that *Diplatys* tests its food with them, giving the morsel a nip, as though to be sure that it is not dangerous, before beginning to eat it. Annandale records how in India a local form of the cosmopolitan *Labidura riparia* Pall., would catch a passing insect with its tweezers, and sometimes hold it in them while eating it, and, if disturbed, run away carrying the prey in its forceps. I have described a female of *Forficula Klebsi* with a fly gripped in its forceps, the captor and its prey entrapped in a piece of gum exuded from an old tree some sixty million years ago, immured for ever, as the gum has been converted into amber.

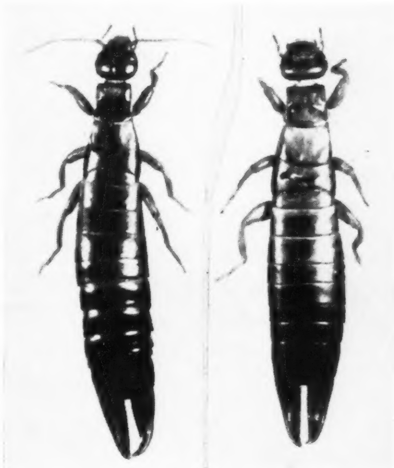
Diplatys Greeni Burr.

Within the order we find almost every possible diversity of design of forceps. In many they are so long or so elaborate that it is difficult to see that they can be of much use to their owners, and seem to have run to extravagance, like the antlers of the Irish elk, which represents the last word in the line of evolution.

There is a curious feature about the forceps of the earwig, which has led to a good deal of confusion among the earlier systematists. Sometimes specimens are found which seem as though they had been better nourished in youth; they are finer, stronger and more powerful than the ordinary males; and at the same time the forceps are very much longer. The effect is curious, as though they had been stretched, with the result that the enclosed space between them, normally more or less circular, becomes an elongate oval or ellipse; any tooth on the upper surface is drawn out into a crest; at the same time, a small horny organ termed the pygidium, at the end of the abdomen between the roots of the forceps, is also involved in this stretching. This phenomenon is termed macrolabiism, and it so completely alters the appearance of the creature, that macrolabious males have often been described as species distinct from the un-stretched, or cyclolabious ones. Macrolabiism is not known in every species, but runs generally through the order, being most frequent in the higher earwigs, and confined to the male sex, with the single exception known to me of *Adiathetus Shelfordi* Burr, from Borneo, where the female is macrolabious. In this case no cyclolabious form has been reported. The two forms occur in our common earwig, and the difference in the appearance of the macrolabious one is very noticeable. For some reason not understood, there does not appear to be an intermediate form, and, at least in Great Britain, the macrolabious form seems to be particularly numerous in the islands round the coast.

It is more usual for insects that live in narrow passages to have sensitive organs at the end of the abdomen, so that they can feel what is behind them. Sometimes the tips of the wings are specialised for the purpose, as in many crickets; sometimes there are hairy tails or cerci, which may be jointed. Many years ago, Westwood described a little creature from Ceylon, to which he gave the name *Dyscritina*, because he could not judge its relationship. It certainly looked rather like an earwig, but instead of tweezers had at the end a pair of long, slender, segmented cerci like antennæ. Mr. E. Ernest Green, first Government Entomologist in Ceylon, made a point of rearing some, and found an astonishing thing, that at the last moult the cerci drop off, leaving only the basal stump, and this turned into forceps. The *Dyscritina* turned out to be nothing more or less than the larval form of a well-known genus of earwigs, *Diplatys*, of which several dozen species are known to-day, all confined to the tropics. Some years later, I found that another group, *Karschiella*, from tropical Africa, presents the same phenomenon.

This important observation caused great interest, owing to it throwing light upon the origin of the forceps, but no trace of segmentation has been reported in the larvæ of any other groups. As the *Diplatyinæ* and *Karschiellinæ* are two of the most primitive subfamilies of the group, there can hardly be doubt that the ancestral earwig possessed segmented cerci throughout life, from which the forceps were evolved. Some years ago, the late Edward Newman suggested that earwigs took their name from the shape of the wings, which is much that of the human ear. This shows that he was not so good a philologist as entomologist. For the trivial names of such creatures must be very ancient, and the notion is probably older than the dispersal of the Indo-European-speaking tribes, as we find it preserved in the French, Teutonic and Slavonic languages. How could primitive man have discovered those marvellous wings, hidden so securely, yet so delicate that to open them is an extremely difficult task ? The first recorded allusion to the possession of wings by the common earwig is in Mouffet's *Theatrum Insectorum*, published in 1634, but written during the reign of Queen Elizabeth.



Titanolabis colossea (Dohrn.) *from New South Wales, life-size. The female is on the right.*

Sir Thomas Knyvet of Norfolk was a remarkably good observer, for there are plenty of country gentlemen to-day who are astonished to learn that earwigs have wings, which they can use to very good effect. The front pair, or elytra, are merely little leathery flaps, which lie at rest upon the back. If these are lifted with the point of a pin, there will be seen beneath two small greyish bundles. These are the wings themselves, in their normal, closed condition. When they are expanded, they are seen to be half a dozen times more ample, iridescent membranes of extreme delicacy. To open them out is the work of an artist. I have never succeeded in performing the operation without tearing them. I have heard it suggested that it may best be done with a blowpipe or under water.

Along the front edge there is a horny scale. The end of this is a hinge, about which the wing closes like a fan. That is not an unusual way for an insect to close its wings, but the remarkable feature of the earwig wing is that it then folds up again in a direction at right angles, that is *across* the ribs of the fan, and that is how it is tucked away so neatly and securely under the leathery flap of the elytra. Only the hardened tip of the scale protrudes. One would think that so elaborate a wing must be a late specialisation, but that it developed at least as early as late Permian times is shown by the remarkable remains from Kansas described by the late Dr. Tillyard, which are accepted by most authorities as those of ancestral earwigs.

The earwig itself has no difficulty in opening these wings ; it lifts the elytra, and shoots the wings out, and when it lands, the wings seem to shut themselves up instantly by their own elasticity. Some have claimed that the forceps are used to help in this operation, but Terry and Riley, who have watched it, say they have never seen them called into play for this purpose, although they do so sometimes, probably if something goes wrong, as Paul Noel has seen the common earwig use them to help put away the wings, and there are other records. When Sir Edward Poulton recorded observations, from Fellows of the Royal Entomological Society, of earwigs flying he received surprisingly few definite answers. They do fly, however, often in great numbers, choosing dark, sultry nights for the purpose. They are, in fact, frequently taken flying to light. Collinge and Riley have seen them fly in broad daylight, as the lesser earwig, *Labia minor*, which is often mistaken for a rove beetle, constantly does.

Just as there is a parallel series of dimorphic forms in the male forceps, so we have dimorphism in the wings of earwigs. In species which are normally winged, wingless specimens occur, and vice versa. The presence or absence of the protruding horny tip of the wings so alters the appearance of the insect, that early writers frequently mistook the two forms for distinct species. This phenomenon, which seems to be independent of locality or sex, is not understood. This brachypterism, as it is termed, occurs also in the Orthoptera and Rhynchota. The most surprising case I ever hear of was the appearance of a fully winged individual of a small black earwig, *Anisolabis annulipes* Luc., a species so totally wingless that not even a trace of the elytra had ever before been noted on one—and the elytra frequently linger on as rudiments, long after the actual flight organs have disappeared.

Book Reviews

An English Style in Art.

Creative Art in England. By WILLIAM JOHNSTONE. (Stanley Nott. 21*s.*)

The publishers of this book are to be congratulated on the production of an exceedingly attractive corpus of English art. There is a very well-chosen collection of masterpieces, many of them little known, some unpublished, which show the thread of the English style in art from Anglo-Saxon times to 1500 A.D. Then the thread is broken, at the Reformation, by the importation of foreign artists like Holbein and Van Dyck, with the consequent depression of local artists, who were forced by their patrons to work in the manner of the foreigners and at the command of rich patrons. Then the tradition, though weakened, is resumed by Constable, Richard Wilson, Cotman, and Blake, only to be broken by the pre-Raphaelites and not sought for again until 1900. The pre-Raphaelites attempted to create the same spirit that had animated the Italians of the period they admired, but all they had as a background was the "other-worldliness," and the hope of a future life, which was the only spiritual undercurrent to the Industrial Revolution. As such it had no force to sponsor a new artistic movement.

In his analysis of the early Anglo-Saxon contributions the author writes with a certain *naiveté*, as if he were the first to discover the glories of Saxon sculpture and painting and jewellery. And he rather confuses the issue by intruding into his list of examples certain Celtic and even Neolithic works from Britain, which have nothing at all in common with the tradition he is discussing. For he has no sense of the fundamental difference between Celtic and Saxon work. He also adds to confusion by giving us the "Franks Casket" as an instance of Saxon style, when it is almost completely Norse. But his Saxon sculptures make a fine showing. The Hexham silver plate, the Easby Cross, the letter "B" from the Harley MS. in the Winchester style, and the Chichester relief, are examples which prove his thesis clearly and beyond dispute. He maintains that, by 1300, the English tradition had been slowly and laboriously forged, with immense scholarship, into a style as fine as anything on the Continent—in many respects finer.

Mr. Johnstone is an enthusiast and not a scholar. His language if forcible and clear, is a trifle diffuse. His choice of plates, with parallels between ancients and moderns, is admirable. A comparison between Gauguin and a 14th-century church painter on plates 76 and 77 is instructive and revealing, and many of his comparisons hold. But his collection of plates representative of the British moderns shows the lamentable confusion of styles and complete lack of co-operation among artists, which is the chief characteristic of to-day. If the young modern artists would collaborate as successfully as did the pre-Raphaelites, or the 13th-century painters of Canterbury, we might again get an English style. The author does not emphasise this need as he should. His attempt to discover a modern English style is stultified, as his illustrations show. But behind the work of painters like the Nashes, the Spencers, Roberts, John, and sculptors like Gill and Skeaping, is an element which can just be discerned in their diversity. The delightful plates of this work allow the reader to discern it after a little reflection. The book should be a success, for it is a considered attempt to illustrate for artists their own heritage, of which they are usually so woefully ignorant. The author is himself an artist and deserves the highest commendation for his achievement. STANLEY CASSON.

The Sociology of Comte

Comte. By F. S. MARVIN. (Chapman & Hall. 6*s.*)

Comte (1798-1857) unquestionably invented the term "Sociology" and thus is entitled to a volume in the "Modern Sociologists" series. But Mr. Marvin has the delicate task, in this thoughtful little book, of explaining that Comte's sociology was by no means identical with the science as developed in countless monographs to-day. The propounder of the Positive Philosophy, or the religion of Humanity, regarded sociology as the science of human relations in the fullest sense, and would have paid scant attention to the laborious collections of social facts which occupy so many of his supposed followers. Comte was primarily concerned with the evolution of mind, and not with details as to the habits of this or that people. For that reason Mr. Marvin is right in singling out the late L. T. Hobhouse as the English philosopher who has done most to work out Comte's main idea, though Hobhouse was not a Positivist and was interested in the study of primitive races. Comte's love of sweeping generalisation is somewhat alien to most of us to-day, except, perhaps, in France. And yet Mr. Marvin can fairly claim that Comte's belief in the ultimate growth of a common consciousness in the human race was never more salutary than now, when the claims of nationalism are being accentuated in some lands to a degree that is not only monstrous but menacing. E. G. HAWKE.

The Earth Goddess. By G. Howard Jones; Royal Empire Society Imperial Studies, No. 12. (Longmans. 12*s.* 6*d.*)

From the title and sub-title (" A Study of Native Farming on the W. African Coast") one might expect that this book would provide a factual discussion of native agriculture in some rational relationship to religion—much as Gompertz did for another era in *Corn from Egypt*. However, no comparison with that concise and cogent work is possible. The treatment of both agriculture and religion in *The Earth Goddess* is diffuse. Two good photographs of idols are supplied, but the discussion of religion is so slight as to lead the reviewer to suppose that the title is mainly metaphorical.

The aim of the book appears to be to make a plea for small-scale farming in a part of West Africa, aided by co-operative marketing, and performed by natives trained by an appropriate course of nature-study. A protest is made against the older methods of teaching, a proposal being put forward for elementary schools of an elastic type, in which the teaching of Natural Science should be more nearly related to the practice of agriculture and hygiene. Irvine's *Text-book of West African Agriculture*, which seems to help fill the need, is not in the bibliography. In *The Earth Goddess* there is no more than a paragraph for students of mixed cropping, a common aspect of tropical native agriculture. Discussion of land tenure occupies much space, but land-hunger is merely mentioned. Although co-operation surely implies local transport, none but the vaguest references are made to transport, again excepting two photographs (of harbours).

An intensive local study of native agriculture could have added much to our knowledge. Comparing the treatments of kindred questions in this book with those accorded by Sir Daniel Hall in the 1935 Heath Clark lectures, the reviewer feels that Mr. Jones has missed excellent opportunities. The general impression left is that one has passed a pleasant time in the company of an agreeable talker who commands a wide range of illustrations varying from Hannibal's elephants to the development of Danish Folk High Schools. The writing is fluent, the digressions amiable. On page 72 there are a number of generalisations which have been insufficiently thought out, but on the whole there is little sign of easy writing making hard reading. It is, however, difficult to say what emerges, or what class of reader—unless it be the earnest teacher of nature study—can benefit, from this book. There is no map.

Hugh Nicol.

The Gods Had Wings. By W. J. Brown: Woodcuts by John Farleigh. (Constable. 7*s.* 6*d.*)

The author calls this a book of unnatural history, and it is indeed a collection of quaint beliefs and superstitions whose origin lies deeply interred in prehistory. Mr. Brown is successful in tracing the sources of many of these fragments of mythology. As the book's title suggests, the sanctity of certain species of birds dates back to the days when they were gods, " immortal, illustrious lords of the air," as Aristophanes has it. Thus, the owl, though loathed as of ill-omen by the Romans, Chinese, and Egyptians, was revered by the Greeks, who, the author suggests, were originally a tribe of owl-worshippers: " before Athene, the owl was." Similarly the cuckoo was, to our primitive ancestors, not only the harbinger of Spring, but the Spring itself; other " identifications " as applied to other birds are of equal interest.

The ceremonial hunting and killing of wren and robin are examples of the belief, so skilfully elaborated in Sir James Frazer's " Golden Bough," that in order to preserve the vital principle inherent in the king—and god—of the tribe he must be sacrificed while in his prime.

In the chapter on Raræ Aves Mr. Brown " debunks " many mythological birds with evident enjoyment. The story of the phœnix he dismisses as " a parable made up by the sun priests at Heliopolis to explain their solar cycle "; the pelican's fabled " piety " is merely faulty observation of its feeding its nestlings by regurgitation from its pink-lined beak; and so on. Incidentally, how many people know that " pedigree " is derived from *pied de grue*, the crane's foot, which was supposed to resemble the divergent lines of a family tree?

This book is a mine of curious information; it is both amusing and interesting, and will appeal as well to the specialist as to the general reader. Unfortunately the absence of an index detracts from its value as a book of reference. Mr. Farleigh's symbolical woodcuts are somewhat cryptic.

E. W. Hendy.

The Preservation of our Scenery. By Vaughan Cornish. (Cambridge University Press. 7*s.* 6*d.*)

Although largely made up of lectures, delivered to such bodies as the Council for the Preservation of Rural England, the Geographical Association, and the Geographical Section of the British Association, this little work is full of charm. One of its most attractive features is the quality of the illustrations; another is their quantity in proportion to the text. They are engraved from the author's drawings—sensitive in line and true in tone—instead of from the photographs usual in books of this type. The volume deals, in a practical manner, with the question of National Parks, and of preserving the fast vanishing amenities of our coasts and wild beauty-spots. But two chapters will more especially interest the lover of " scenic geography " (the author's name for the æsthetic aspect of that science): one shows the influence of different species of trees and various types of rural architecture on English scenery; Dr. Cornish beautifully describes the harmony of the older rural architecture with the scenery that surrounds it. The second of these two chapters deals with the geological reasons for the many and sudden changes in the character of the cliffs. The author pleads for the reservation of a strip 110 yards wide, on all our sea-cliffs, as an open space, to preserve the character of the view. On the East Anglian cliffs, whose erosion, owing to their soft nature, is—alas!—proceeding apace, this might be difficult. Dr. Cornish is, no doubt, aware of the fact that a public right-of-way has long existed all round the coasts of Great Britain; even this has become rather a problem with owners of long-established houses and grounds near the cliff edge—at any rate in the author's native county of Suffolk.

Binding and print are worthy of the illustrations and of the subjects.

Mary Barne.

Prelude to Chemistry. By John Read, F.R.S. (Bell. 12*s.* 6*d.*)

The debt of modern chemistry to alchemy has been at the same time overestimated and underestimated. While the concrete results actually achieved by the mediæval alchemists

were surprisingly scanty, the method of work employed by the best of them set a standard that the modern researcher has to strive hard to attain. Those of us who think of an alchemist as a bearded elder, clad in cabalistically-marked garments and surrounded by odd-shaped instruments, working under the hollow gaze of a stuffed crocodile, are rather wide of the mark. No doubt the despised " puffers," who simply sought to make gold, surrounded themselves with these childish mysteries to impress the unlearned ; but the genuine alchemist was an earnest searcher after truth, attempting to found a philosophy on the essential oneness of nature, though his cardinal principles may seem ridiculous to us to-day.

Professor Read has written a detailed account of the whole alchemical period, from its origins in Egypt and China, through the Arabian era of development, to the latest European developments, extending into the 18th century. He has done a great service in showing the shortest way across " an illimitable ocean of misty monotony," pointing out a few interesting islands on the way. For, in fact, alchemical literature is mostly dreary, maundering stuff, from the writings of Wei Po-yang to those of Michael Maier. Happily, however, the illustrations are usually lively and curious, though their significance is not always clear ; and Professor Read has been lavishly generous with his illustrations, from the brilliant frontispiece taken from a Harleian MS. down to the quaint little text-vignettes.

Several interesting questions are raised. Did Nicolas Flamel actually make gold ? If not, whence came the wealth with which he endowed so many charitable institutions ? At all events he was a real and a human person, with a genuine affection for his wife and assistant, Perrenelle. Incidentally his tomb-slab (now in the Cluny Museum) is one of the few concrete alchemical relics still extant.

What was the Philosophers' Stone ? The idea of a universal touchstone seems to have emanated from the East, and its ubiquity was generally recognised, but, as usual, it soon becomes buried under a mass of verbal mystification. From the many titles used to describe it we choose at random : Xit, Sophic Hydrolith, and Stomach of the Ostrich (not a bad name for an all-digesting acid).

The methods used to find the Stone may have been ridiculous (*e.g.*, that one which postulated a *universal* solvent to be contained in a glass vessel), but much alchemical phraseology remains with us, for example, " hermetic," " the music of the spheres," and so forth.

Another mystery is the personality of the alchemists themselves. So customary was it to apply a famous name to an alchemical work, that the real authors are scarcely known. Hermes Trismegistus himself is credited with innumerable treatises, and more modern writers, Cremer, Norton, and Basil Valentine fade more and more into unreality the closer they are examined. However, Professor Read makes them live, as far as shadow actors on a phantasmagorial stage can be said to live ; and who shall say that alchemy is not worthy of study when Newton himself wrote 650,000 words on the subject and President Hoover had a hand in translating an alchemical treatise ?

Accidents and their Prevention. By H. M. VERNON. (Cambridge University Press. 15*s.*)

In view of the amount of public attention directed towards road accidents, Mr. Vernon's latest book is as timely as it is interesting. The author presents his facts with considerable thoroughness and, though the experience on which his book is based is mainly British, investigations made in many foreign countries are used for illustration and comparison.

The book opens with a summary of the size and nature of the accident problem in this country. It soon becomes clear that Road Accidents (which in 1931 accounted for nearly 40 per cent. of all fatal accidents) are extemely important. The information on this subject is collected and analysed more adequately than by any previous writer, and much space is devoted to possible remedies. Here, as elsewhere, Mr. Vernon rejects the idea of unpreventable accidents. He argues that improvement can be brought about in three ways : first, by the introduction of safety devices, second, by legislative action, and lastly, by education. The effectiveness of the last is well illustrated by experience in America, where much stress is laid on teaching the principles of road safety in the schools. As a result accidents have fallen among children although at other ages they have increased. The same is seen in London, where more attention is paid to education for safety than is common at schools in other parts of the country. Mr. Vernon is often at his most interesting in more technical passages, and his discussion of the effects of sub-intoxicant quantities of alcohol on nervous reaction deserves the greatest possible publicity in view of popular illusions.

The author has much of value to say on the causation of industrial accidents. He gives no general function showing the dependence of accidents on the relevant independent variables, but a great deal is said on the influence of individual factors, such as experience, age, temperature and the like, on accident frequency, or severity in isolated cases. It is clear from the instances cited that by taking a little thought and care a great deal can be done to reduce the number of industrial accidents. Another section deals with accidents in the home. This subject has not previously attracted much attention and should therefore prove all the more interesting, particularly to those who come into frequent contact with young children. Space forbids further comment on the other topics discussed in this book, but in conclusion it must be said that its printing and preparation attain the high standard that we have come to expect from the publishers.

The World of Science. By F. SHERWOOD TAYLOR. (Heinemann. 8*s.* 6*d.*)

Everyday Science. By A. W. HASLETT. (Bell. 7*s.* 6*d.*).

Science in Daily Life. By G. H. TRAFTON and V. C. SMITH. (Lippincott. 8*s.* 6*d.*)

During recent years there have appeared many books of the type of these, seeking to bring a knowledge of science to the non-scientific layman by setting out in attractive style either the principles of science or the scientific evolution of the great mechanisms of today. These are written not merely to amuse, but to impress upon the minds of all the contact between science and daily human life and the fact that science is no longer bounded by the walls of the laboratory. The authors feel that it is vital to the preservation of our civilisation that the public should become " science-conscious " for otherwise science may bring about great social disaster.

Hence it is the duty of everyone to interest himself in the development of science and it is this type of book which is necessary both to the layman and others for this purpose and I venture to say that of this type *The World of Science* and *Everyday Science* are masterpieces.

Dr. Sherwood Taylor's book is remarkably well produced. It has many fine illustrations and the lay-out is pleasing. The

exposition starts with a lucid explanation of the atomic concepts of matter, touching, in the light of this, on the simpler properties of matter. Then come under review the elements of engineering and the problems of power and its use, and so (logically) the practical and theoretical aspects of electricity come up for treatment. In turn the study of waves and vibrations in general are treated and then the practical aspects and uses of waves—the gramophone, telephone, moving pictues, to mention just a few. Having thus examined the ultimate structure and properties of matter and energy, the outlines of chemistry are sketched in a m ost fascinating manner, the practical aspects, such as metal corrosion and air pollution, taking precedence over matters of more theoretical interest. The next section deals with the Earth—its structure and formation—and the Heavens—the nature of the Sun and planets, stars and nebulæ. Then follows the section which appears to me the most excellent of all: that on Life. This first explains what is meant by life and then the functions of the living cell and develops into an unbelieveably lucid description of the mechanisms of the human body. After dealing so thoroughly with Man the story passes on to animals and then to plants and bacteria; and the whole is linked together in the next chapter on "Evolution."

This is one of the most remarkable books of its kind ever published and it is plain that such a mass of knowledge could be brought together only by the use of such a plan as has been evolved in the crystal clear brain of Dr. Sherwood Taylor.

Mr. Haslett's book is written from quite a different angle. He explains, in terms and language which equal those of Dr. Sherwood Taylor in their simplicity and clarity, the principles underlying the everyday applications of science and the social implications of the changes caused by these applications. He tells of the influence of science on architecture, diet, health, leisure and there is an excellent chapter on Science and Crime. His book is perhaps a little haphazard in its arrangement but I recommend it to all as a most excellent book and well worth the price.

Messrs. Trafton and Smith's book is one for use in American schools and deals most fully with its subject—"Science in Daily Life." It has some very interesting demonstrations and applications described in its 670 pages and I think the section entitled "How can the number of Automobile Accidents be decreased?" could profitably be read by all. All science teachers should include it in their reading list, as they will find in it many points of use in their profession. Others who read it will realise that our homes, cities, clothes, food, etc., have not just "happened," but are the results of long processes of scientific investigation and experiment. In short, if at all possible, read all three of these books.

Intermediate Chemistry. By T. M. Lowry and A. C. Cavell. (Macmillan. 12*s.* 6*d.*)

Nearly two hundred experiments, which have survived the test of use in school classes and which are believed to be of real value in practical work, *i.e.*, analyses and preparations, provide an important feature of this book. In addition to general and theoretical matter and a study of typical elements, there are separate sections upon analysis (5 chapters), physical chemistry (14 chapters), and the principles of organic chemistry (15 chapters), the total number of chapters in the book being 61 This wide range of subject matter is very acceptable within the covers of one volume. The book, considered as a whole, has been written to meet the needs of Intermediate and Higher School Certificate Examinations; the section on organic chemistry includes matter which is prescribed in the syllabus recently issued by the University of London. Useful tables giving a comparison of the properties of the compounds of related elements are given at a number of places in the text. Questions, collected from past examination papers, are grouped together at the end of the book.

Modern Elementary Chemistry. By F. Sherwood Taylor. (Heinemann. 5*s.*)
Handbook to Modern Elementary Chemistry. By F. Sherwood Taylor. (Heinemann. 6*s.*)

The first book, in the words of the author, claims "to teach nothing which the student will later have to unlearn." It covers all the needs of the student for a matriculation course, and makes a special point of stressing fundamental principles and of giving a clear explanation of difficulties. Many phases of the subject matter are presented in a way not commonly adopted in the plan of elementary chemistry textbooks; there are also other novel features, *i.e.*, a number of cases where properties have been tabulated to show more conveniently and more strikingly the relationships of various elements. Outline directions for experiments are placed at frequent intervals, and each chapter is terminated by a group of questions. Full details of apparatus and materials which are needed for lecture demonstrations and class experiments, however, are given in a separate "handbook." This has been done mainly to permit the textbook itself to be published at a low price. The handbook also includes discussions upon teaching methods, alternative explanations, detailed answers to numerical questions (given in fractional form to save timeand also to indicate method of working), tables of solubilities, etc.

Manual of Meteorology, Vol. II. New and revised Edition. By Sir Napier Shaw, Ll.D., Sc.D., F.R.S., with assistance of Elaine Austin, M.A. (Cambridge University Press. 36*s.*)

The first of the four parts of the *Manual* to reach a second Edition, Volume II is also the section where revision is most useful, and it is a happy coincidence that public demand has thus catered for the needs of science. Volume II deals with "Comparative Meteorology" and certain of the many tables and summaries of data incorporated therein are necessarily modified by the data which have been accumulating, during eight years, since the original volume was published. Complete revision of figures embracing records from all parts of the world was clearly impossible, but the author has dealt with those cases where correction had become most necessary, and has also introduced several new illustrations, notably three representations of monthly means in Chapter VII. The most interesting change, however, is the replacement of the chapter on the "foundation of theory" by a chapter of "notes and supplementary tables." This consists of lists, notes and summaries of additional out-of-the-way information—for instance, a bibliography of meteorological charts, a note on the duration of snow-cover, a table of the rates of travel of cyclones and anticyclone in different parts of the world—and in nearly all cases sources of fuller information are quoted. This new supplement, and the authorities given in other chapters for the data used, make the volume invaluable to the student of meteorology, not only as a collection in itself of every kind of meteorological data, but also as a guide to sources of detailed information. For the benefit of

those readers who have not seen the original it may be mentioned that the volume throughout is profusely illustrated by ingenious and diverse diagrams which will be much appreciated by the learner.

Cambodian Glory. By H. W. PONDER. (Thornton Butterworth. 15*s*.)

Mrs. Ponder strikes a very happy note in her description of Cambodia. Without delving into the profundities of archæology or ethnology she provides a well-observed account of the strange and magnificent monuments of Angkor: more than that, she succeeds in supplying her account with a really convincing background. Her descriptions are three-dimensional, and the reader—scientist or layman—sees the mysterious buildings, with their four-faced pylons, friezes of dancing Apsaras, avenues of lions and elephants, and all the rest of the teeming millions of sculptures and reliefs, in a proper perspective. Due importance is given to the life of modern Cambodia, and to our somewhat scanty knowledge of its history. As to the history of Angkor—even the date of its erection eludes the most learned: no sooner is a theory established than new facts or half-facts arise to throw doubt upon it. Since the book was written, a new hope of dating the ruins accurately has arisen, with the discoveries made by Dr. Quaritch Wales and his expedition in Central Siam, of the remnants of what is probably the oldest Indian settlement in Indo-China (see DISCOVERY, Nov. 1936). We are still a long way from Angkor, of course, but something may come of this after a few more seasons' work. The descriptions of Cambodia ancient and modern, of vast works of art and of petty everyday occurrences, are vivid, entertaining, and easy to read, but the author or proof-reader must learn how to spell "colonnade" before treating of any further antiquities where this architectural feature is so frequently repeated.

A Short History of the Future. By JOHN LANGDON-DAVIES. (Routledge. 10*s*. 6*d*.)

Most people have their own private ideas of what is in store for the world in the next fifteen years. Many look as far as the next war and no farther. Mr. Langdon-Davies's prognostications are interesting inasmuch as he looks well beyond the next war (1940) to the death of democracy (1950), the time when work will be limited to three hours per day (1960), the end of the system of family units (1975), right up to the stage at which "race problems will all be solved; there will be one race in the world, with a pale coffee-coloured skin . . ." (4000). Some of the author's deductions are not easy to follow, but the sympathy of the reader will be mainly with him, particularly in his strictures upon the anomalies of advertising and of legislation on sex matters.

Naven. By GREGORY BATESON, M.A. (Cambridge. 18*s*.)

Mr. Bateson's cryptic title is the name of a remarkable ceremony which he has found and studied among the head-hunting Iatmul people of the Sepik River in New Guinea. It is performed at the accomplishment for the first time of an act of a ceremonial character or ritual importance, such as the first head-taking by a boy or youth. It is initiated by the mother's brothers of the hero—for that is what the ceremony constitutes the individual who is its occasion. Dressed as old women they stagger around the village ridiculously; but the crowning act of the performance is when the central character marches over the naked bodies of the women prostrated before the door of the men's club-house. The striking feature of the ceremony is that men and women wear the clothes and ornaments of the opposite sex. With this ceremony in all its curious detail as his starting point, Mr. Bateson has fashioned an elaborate mosaic of Iatmul culture, treating the ceremonial as a focusing point of structure, emotion, and social implication. In other words he shows how three lines of investigation, differing in the aspect of study, radiate from this common subject-matter to subserve the interpretation of Iatmul society as a complete and complex whole.

Mr. Bateson makes no attempt to 'explain' the Naven ceremony, either as a whole or in its parts. His interest is neither historical nor evolutionary, but purely functional.

Alone Across the Top of The World. By DAVID IRWIN. (Robert Hale. 10*s*. 6*d*.)

Books describing epic journeys in the frozen North appear with monotonous regularity. One man's story is very like another's: meeting with Eskimos, quarrels, dogs dying, food shortage, injuries, etc. Mr. Irwin's story is no more epic than most, his description is somewhat prosaic and very personal, and the illustrations are below average. Any book of this type, however, can be read with pleasure, and this will interest hardened readers, especially on account of its references to Andy Bahr, Knud Rasmussen, and other well-known polar characters. Incidentally "Top of the World" in the title is not literally correct. Irwin's journey was from the mouth of Canning River, Alaska, to Baker Lake, near Hudson's Bay. Barter Island, Alaska, was the furthest north touched, while about a quarter of the journey, from Fort Good Hope to beyond the Great Bear Lake, was south of the Arctic Circle.

Short Notices.

Back to the Stone Age (CHARLES CHEWINGS; Angus & Robertson, 7*s*. 6*d*.) is a somewhat unsatisfactory account of the personal and tribal lives of the Central Australian natives. Dr. Chewings has written primarily for the general reader; but there is insufficient humour and colour for these, and not enough detail for the anthropologist. It is, however, a painstaking work, and the illustrations are much above the rather low general level of those of the Australian natives.

Lady Barn House and W. H. Herford (W. C. R. HICKS; Manchester University, 7*s*. 6*d*.) is a sympathetic and intuitive portrait of the school, which was taken over in 1935 by the University of Manchester. Sir Michael Sadler contributes a preface. Those interested in the theory of teaching will find much to interest them.

The New Chemistry (E. N. DA C. ANDRADE; Bell, 3*s*. 6*d*.), which the author informs us is an expansion of a post-graduate lecture delivered by him early in 1936, gives a most interesting and lucid account of recent work on the transmutation of one kind of atom into other kinds of atoms. It is entirely non-mathematical and the clarity of the treatment is enhanced by many beautiful photographs and diagrams. It should be very popular with all persons who are interested in scientific progress.

A Manual of Radiological Diagnosis (I. C. C. TCHAPEROFF; Heffer, 21*s*.), as the foreword states, fills a patent gap in the X-ray field. The X-ray negatives are copious and excellent, admirable for the use of both student and practitioner. It is usefully pointed out that X-ray diagnosis is a supplement to, not a substitute for, clinical examination.

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